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The rebirth of the U.S. keyboard market PAGE 116

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VBPA ABP

Record year for semiconductors: A $32 billion world market

Of this larger pie, the U.S. has a smaller share. But U.S. companies did much better than last year

Fade into oblivion, 1984. Step aside, 1986. At only $26 billion, you are no longer the biggest years in world semiconductor market history. That distinction belongs now to 1987. The world will have bought $32 billion worth of chips by the time this year is over, 22% more than in 1986, according to the recent forecast by the Semiconductor Industry Association. Moreover, says the trade association, 1988 will be even better with almost as much growth, 18%.

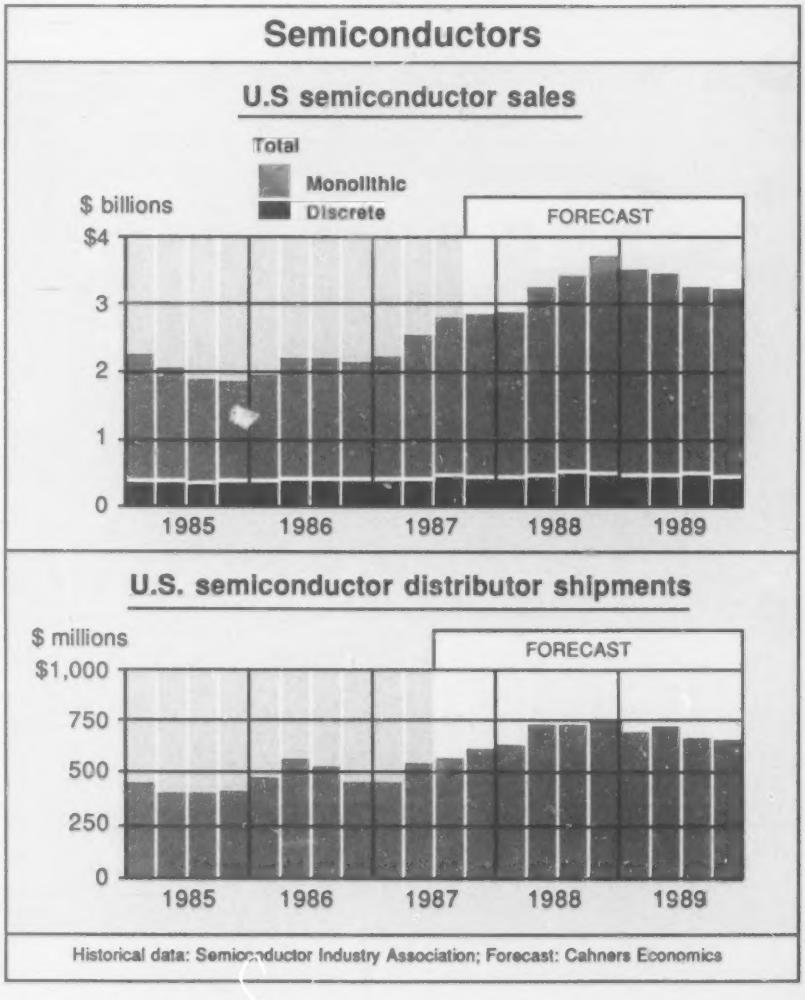
It is not the first time that the SIA's World Semiconductor Trade Statistics group has forecast a rosy future from the vantage point of a good year. Unfortunately, when it did so back in September 1984, it predicted that 1985 would be the year of the $32 billion world market, thus completely missing the recession that shrank the market to only $21.5 billion.

But the SIA is on very firm ground with its 1987 forecast, especially with its prediction of 20% growth for the U.S. market. Domestic manufacturers have moved aggressively to defend their growing turf, as weil as to participate in the worldwide market. Intel Corp.'s revenue proves it has done so successfully. Its sales increased in the third quarter by 55% over last year, after growing 42% in the first half. ASIC specialist LSI Logic saw its revenue increase by 49%, the same percentage as linear specialist (but six times smaller) Linear Technology Corp. Even Advanced Micro Devices Inc., which has been slow to participate in the recovery, advanced 14% in the third quarter, after an increase of 18% for the first half.

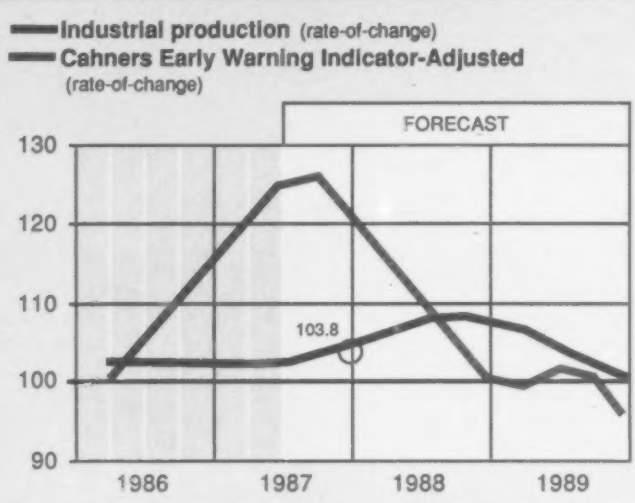
Conservatively, the SIA forecasts another 20% increase for the U.S. market in 1988. Based on the Cahners Early Warning Indicator, economist Elizabeth Baatz forecasts that the U.S. market will gain 22% this year and do even better, 28%, in 1988. Unrelated to Cahners' methodology, but supporting its conclusions, is the fact that the revenue of big users of chips have been increasing substantially. In the third quarter, Digital Equipment Corp. advanced by 24%. Workstation specialist Sun Microsystems Inc. doubled its revenue in the same period. And, on its way to becoming a billion-dollar company, Seagate Technology's sales grew by 20%.

When analyzing the $32 billion world of semiconductors, the sobering fact emerges that the largest share, 38%, is Japan's. This country won leadership through both the internal growth of its electronics consumption and the strengthening of its currency. To free its forecast from the influence of the latter factor, the SIA has forecast Japan's market in yen. It predicts a slow 2% growth for this year, and a healthier 13% for 1988. If so, the U.S. may regain next year some of the ground it lost to Japan.

ALBERTO SOCOLOVSKY



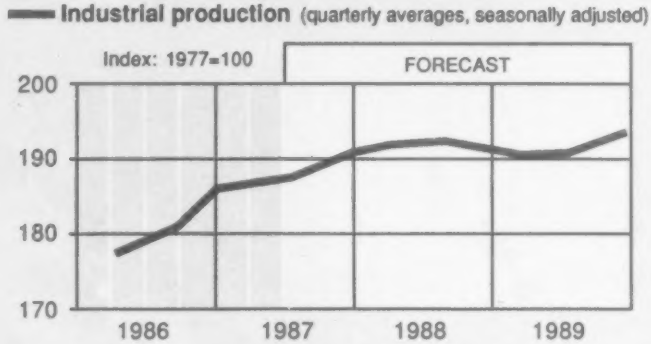
Economic indicators



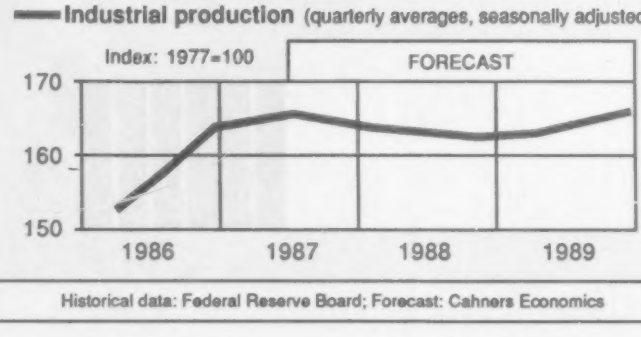
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Industrial production

Defense and space equipment



Aircraft and parts



Historical data: Federal Reserve Board; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. This spring output rose 0.7%, according to estimates from the Federal Reserve Board. This slow and steady growth is expected to continue until next summer. Production is expected to rebound after a year and a half of sluggish growth pushing production up 6.8% in 1988. The impetus for this upturn will be increasing U.S. exports, due to the decline in the value of the dollar, inventory replenishment and growth in business equipment investment.

The Cahners Early Warning Indicator has been adjusted by deleting the unusual effects of recent changes in financial markets. The adjusted indicator points to an upturn in the economic business cycle with the next business peak in August of 1988. This leading indicator, (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index, has proven to be an excellent forecasting tool. It forecasts the turning points in the economic business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 103.8 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.8% above 1986.

More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

Defense and space production

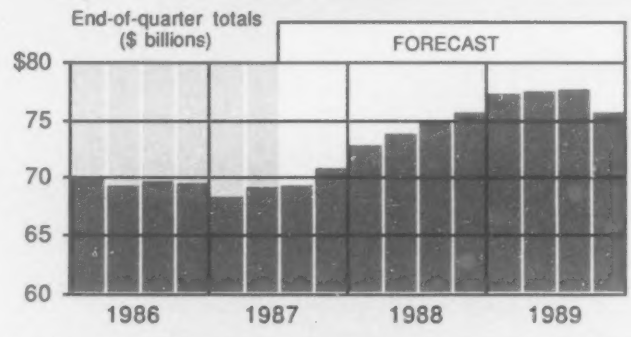
Production of defense and space equipment rose 0.2% in the second quarter and is expected to rise another 0.8% in the third quarter. Stronger gains in the fourth quarter are expected to push annual growth to 4.1%, down 1.2% from last year and 5% below 1985's growth rate. Defense equipment production will slow even further in 1988 and 1989 as federal budget constraints loom.

Aircraft and parts production

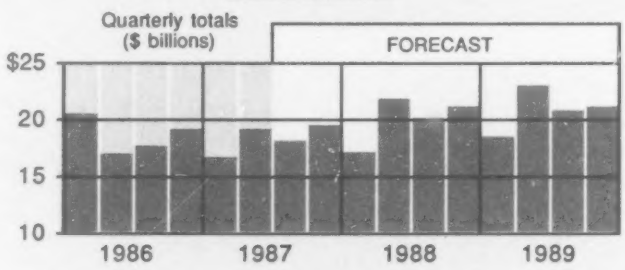
After a 0.5% gain in the second quarter, output of aircraft and parts is expected to fall in the second half of the year. Stronger gains early in 1987 will still push annual gains to 4%. While disappointing after over 10% annual gains in the previous two years, the business cycle points to an even sharper slowdown in 1988. Orders for aircraft were weak in the first half of 1987 as a 27% surge in commercial orders failed to completely offset an 8% drop in defense aircraft orders.

Communication equipment (SIC 366)

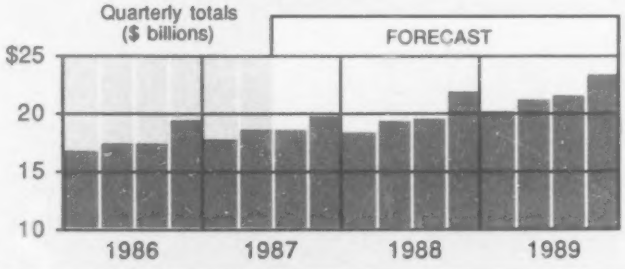
Unfilled orders



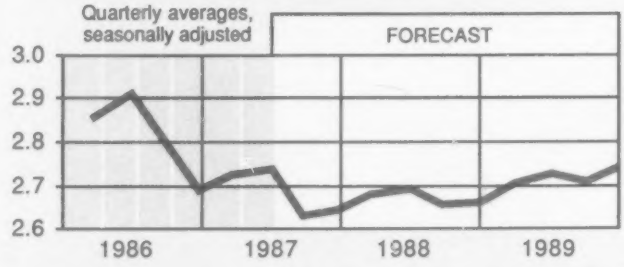
New orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

In the third quarter, new orders for communication equipment rose an estimated 2.8% above a year ago, but fell 5.7% below second quarter orders. Even an expected 1.1% increase in the current quarter will only push communication equipment orders to $72.4 billion for 1987, 1.2% below 1986 and 4.7% below 1985's record orders. Most of the decline in orders so far in 1987 has been due to a weak defense sector. Orders for communication equipment from defense buyers fell 15.4% in the first seven months of 1987. Luckily, commercial markets are rebounding and are expected to offset defense losses next year. Orders from commercial buyers actually jumped 13.7% in the first seven months of 1987. In 1988, all communication equipment orders are expected to rise 9.2%.

Unfilled Orders

Backlogs of communication equipment have remained fairly steady, according to the Census Bureau's tabulation of last summer's data. At $68.2 billion in August, backlogs are down just $200 million from last spring and $600 million from a year earlier. With orders now on the rise, especially in the more competitive, market-driven commercial markets, expect backlogs to inch upward throughout 1988 and into the first half of 1989.

Shipments

Compared with the second quarter of 1987, shipments of communication equipment rose 0.5% in the third quarter of 1987 to top year-ago shipments by 6.9%. Fourth quarter gains were probably a bit more modest, but by the end of 1987 shipments are likely to have hit $73.4 billion, a 5.3% annual gain. Shipments are expected to rise another 5.9% in 1988 and 9.6% in 1989. Any negative years are not likely until 1990 when the business cycle heads back down. But any expected business cycle downturn will be weak in amplitude and short in duration.

Inventory-to-shipment ratio

Paralleling the tightening of inventory in other industries, communication equipment inventory-to-shipment (I/S) ratio fell to 2.62 in August 1987, down from 2.80 in February. Over the February-August time period, inventory rose 2.4% but shipments rose 9.4%, pushing the I/S ratio down. This ratio stood at 2.62 in November 1986 and has been hovering between 2.8 and 2.6 ever since. The last time the I/S ratio stayed in this range was back in early 1983. With rising interest rates and the increasing cost of holding inventory, the I/S ratio for communication equipment should remain relatively low next year.

KOREAN ELECTRONICS

What Korea's elections mean to U.S. electronics firms

First the labor strikes; now, the vote on a new president. U.S. suppliers *and* buyers are on alert

"This will be my first time to vote. Still, I cannot believe it," says a Seoul taxi driver in his early 30s. For more than 16 years, South Koreans have been denied the right to participate in evenhanded elections. But after massive social unrest last spring, President Chun Doo Hwan finally agreed to step down after years of authoritarian rule. Koreans are understandably elated about the upcoming presidential election, just days away.

Across the Pacific, American executives, supplying equipment to and buying products from Korea, are also on the alert. And with good reason. U.S. companies doing business in Korea have pumped more than $1.2 billion into the country, according to the Korean Ministry of Finance. In electronics products alone, North America's trade with Korea — imports plus exports — topped $4.8 billion last year.

Although all four presidential candidates in the upcoming election are violently clashing on a myriad of issues, they all have agreed on one thing: the miraculous progress of Korea's economy, which grew 12.5% in real terms last year, *must* continue. "The economy here is on a roll and no one is going to tamper with that," says Steve P. Tsitouris, managing director of AT&T's Seoul office.

In fact, the economy is a virtual nonissue in the campaign. By American standards, the election in Korea has become more of a personality contest. None of the candidates has outlined any definitive economic plans yet. Still, differences in the backgrounds and ideologies of the four men will probably have an impact on their decisions in labor and trade policies, two crucial areas of concern for U.S. companies doing business with Korea.

Of the four candidates, former Prime Minister Kim Jong Pil is seen as the long shot. He is a conservative backed by Koreans wanting little change. Also of a conservative nature, Roh Tae Woo, President Chun's hand-picked successor, has strong ties with the military and business community. Opposition candidates Kim Young Sam and Kim Dae Jung are viewed as being reformatory and liberal, although by American political calibrations, they are really right-wingers. Kim Young Sam is considered the more moderate of the two.

Opposition candidates Kim Dae Jung, left, and Kim Young Sam. Good for labor but bad for foreign trade?

Until last summer, Korea's economy was humming. The country recorded a $3.1 billion trade surplus last year, its first in modern times. In particular, Korea's electronics industry grew by a mind-boggling 45.6% in 1986, according to the Electronic Industries Association of Korea (EIAK).

Labor woes

Then came the labor strikes. The Korean Labor Ministry now admits that the country suffered more than 3,300 strikes by hundreds of thousands of workers last summer. In sharp contrast, the government recorded just 276 labor disputes in all of 1986. Korea's well-tuned export-driven economy nearly cracked under the pressure. The country's Ministry of Trade and Industry (MTI) reported that although trade surpluses were averaging more than $500 million a month earlier this year, the August figure had nosedived to $94 million.

Although the strikes were concentrated in the automobile and shipbuilding industries, high-tech companies were also affected. At Daewoo Electronics Company Ltd., factories closed for two weeks causing delivery times to double. Goldstar Semiconductor Ltd.'s shutdown lasted 10 days. MTI conceded recently that Korea's electronics exports were $200 million off target last August.

Virtually all of the manufacturing strikes were settled by summer's end and MTI asserts that export and production numbers have since rebounded. But Korea's new president, whoever he may be, must deal with the distinct possibility of further labor problems when wage contracts are renegotiated this spring.

Although average salaries in electronics manufacturing were increased

UPI/Bettmann Newsphotos

UPI/Bettmann Newsphotos

Social unrest and labor strikes upset Korea's economy last summer. The government now admits that it was $200 million off target for August electronics exports

by more than 25% this year, many workers say it was not enough. "Yes, we did get a large raise but our pay was so low to begin with," complains one blue-collar worker whose hours run from 8:30 a.m. to 8 p.m., six days a week, at Goldstar's personal computer factory in Pyongtaek. Indeed, even after the recent salary raises, skilled Korean employees in electronics assembly are averaging just $1.50 an hour, according to the Center for Foreign Investment Services in Seoul.

Management now concedes that mistakes were made. "Korean industry has grown at the expense of our workers," admits Park Kwang Oh, a vice president in charge of semiconductor R&D for Hyundai Electronics Industries Company Ltd. "Some workers feel that they have been sacrificed," acknowledges another Korean company executive.

Bitter resentment

However, many white-collar employees bitterly resent the concessions won by their blue-collar counterparts. Lee Kuen Tae, deputy general manager of the planning department for Daewoo Electronics, complains that a 27-year-old college graduate working for Daewoo now earns less than a manufacturing employee of the same age. "Next time we have any labor disputes," says Lee, "we will have a stronger government to help us."

Indeed, many business executives privately complain about President Chun's lax handling of the labor strikers. Political analysts explain that Chun, who seized power through a military coup in 1980, restrained himself last summer in order to curry favor with Korea's huge bloc of middle-class voters. In the past, when free elections were nonexistent, the government and big business conspired to keep wages low in order to fuel economic growth, allege many Korea watchers.

Not surprisingly, the big business community is rallying behind right-wing candidates Roh Tae Woo and Kim Jong Pil, both perceived as willing to use strong-arm tactics to keep the country in order. And the labor movement favors the opposition candidates. "Kim Dae Jung would probably bring about the democratization of the unions the quickest," says Lee Eun Jin of the Korean Labor Association.

A scheduled collision

Korea's new president will need to act fast. Labor and management are headed for a collision next spring when contracts are scheduled for renegotiation. Labor union insiders say they will be demanding an overall average wage increase of 15% and an even higher increase for workers in the electronics industry. Management and government officials, on the other hand, say they are still recovering from last summer's concessions. "We know that a double-digit wage increase will be expected and that is our problem," says Seo Sa Hyeon, a director of MTI's Electronic Industry Bureau.

To make matters worse, management and labor have little experience in dealing with one another. It is the classic example of two opponents who have made the mistake of underestimating the other's strength. "Management is retrenching and

Electronics assembly workers in Korea still earn about $1.50 an hour even after a more than 25% pay raise

starting to go back on some of its promises," notes George Long, research analyst with investment brokerage W. I. Carr Ltd.'s Seoul office. Such talk does not scare one labor union leader who says, "Every employer is really frightened of us."

The good news for America is that any future labor unrest will probably be contained within only the Korean companies. U.S. firms escaped relatively unscathed last summer because they were generally paying higher wages and providing better working conditions in Korea than the indigenous companies were. Molex Inc., a Lisle, Illinois-based manufacturer of connectors, experienced a 4-hour strike in its Ansan factory. Tandy Corp. reported "minor" problems in its two Korean plants where the company makes cellular phones and electronic components. Bigger losers were those U.S. companies involved in a Korean joint venture. AT&T owns 44% of Goldstar Semiconductor, victim of a 10-day shutdown.

Further labor problems could lead to trouble for the hundreds of U.S. companies depending on Korean parts or products. Last year, North America imported $3[illegible] billion worth of Korean electronics goods, according to the EIAK. IBM alone will buy around $180 million this year, according to John Bishop, president of IBM Korea Inc.

But because of the current political and economic uncertainties in Korea, many U.S. customers have become wary. "Being totally dependent on Korea at this point is suicidal," asserts Jerry Wasserman, a vice president for Arthur D. Little Inc., a Cambridge, Mass., consulting firm. Still, some U.S. companies remain solesourced on Korean suppliers. Vodavi Technology Corp., a telecommunications company in Scottsdale, Ariz., depends totally on Goldstar for manufacturing. After saying he is "broadly concerned" about the situation in Korea, chief executive Stanley Blau adds, "we are currently discussing with Goldstar the possibility of them manufacturing our products outside of Korea." No decision has been made yet.

President Chun will soon step down. Under his strict rule, Korea's electronics industry grew 45.6% last year

Leading Edge Hardware Products Inc. of Canton, Mass., may also be courting trouble. The company buys all of its Model D personal computers, of which it has sold 350,000 units so far, from Daewoo. "Last summer we didn't experience any glitches in supply but there's no question that we were concerned," says John Sullivan, marketing vice president. "We're watching the situation now with guarded optimism."

Simmering trade friction

Labor problems will not be the sole concern of Korea's new president. Simmering trade friction also threatens to upset the country's economic apple cart. Many a U.S. politician has pointed an accusing finger at the flood of Hyundai cars, Samsung televisions and Goldstar VCRs pouring into the American marketplace. The United States' $7.4 billion trade deficit with Korea in 1986 and Wall Street's crash last October, which many analysts feel was touched off by disappointing U.S. August trade deficit figures, have only intensified calls for retaliatory measures.

"Korea now realizes that it's a give-and-take situation and we will open our markets more and more," asserts Park Baeng Moon, a general manager of the corporate planning office for Samsung Electronics Company Ltd. Indeed, via a goodwill visit to the United States last summer, Korean electronics executives purchased more than $300 million worth of products from U.S. concerns.

Furthermore, the Korean government, under the leadership of President Chun and his deputy Roh Tae Woo, has removed many market restrictions and lessened various import tariffs. Foreign personal computers are now being allowed into the country and tariffs on electronics products have been slashed by one-third, according to the EIAK. Nonetheless, foreign executives say the Korean government still has quite a ways to go. "A Ford Taurus should not cost $57,000 in Seoul," complains one U.S. expatriat.

But whether Korea's new president will continue pushing market doors open is unknown. Ironically, both op-

position candidates Kim Dae Jung and Kim Young Sam have actually been more conservative and nationalistic in their foreign trade views than their opponents. Both Kims have blasted the current government by saying that acquiescing to U.S. interests will lead to higher Korean unemployment.

Some political analysts say the United States should not be concerned because the Kims' accusations are nothing more than campaign rhetoric that serves two purposes: provides the Kims with something to complain about and allows them to win favor with Korea's workforce and unions. Nonetheless, U.S. business executives should be concerned if one of the two Kims does win. Critics say neither Kim Dae Jung nor Kim Young Sam has the political diplomacy or foreign relations expertise necessary to balance Korean jobs against U.S. calls for market liberalization.

Philippines-like chaos

For the time being, the primary concern for U.S. businesses is that the elections are held without disruption. Any attempt to rig them might send the country spiraling into Philippines-like chaos. Although Koreans bristle when they hear the comparison, Korea's tortuous history suggests that the analogy is not totally unwarranted.

Since being established in 1948, South Korea has yet to see a peaceful transfer of leadership. President Chun seized power after the previous president was assassinated by his own secret intelligence director. Korea is a country where military coups and martial law are well known. "I smelled tear gas there for the first time," says one American businessman who is now back in the United States. Some posh hotels in Seoul now provide their guests with gas masks.

Further labor problems could lead to trouble for hundreds of U.S. companies depending on Korean parts or products

Still, Carter Eckert, professor of Korean studies at Harvard University, says, "It'll be very difficult for the government to control the election at this point because the whole world will be watching.... If the election is contrived, it'll be fairly obvious and there's going to be an outrage." Eckert, who is currently in Seoul on a task force to help deter election fraud, adds, "The elections are going to have to be fair. But I'm going to have to find some wood to knock on."

Some foreign firms are jittery. "We've made alternate arrangements for getting material into and out of Korea," says Sandy D'Arcy, managing director of international sales and marketing for VLSI Technology Inc. of San Jose.

Rumor has it that Japan's Sanyo Electric Company Ltd. will relocate its three Korean plants to Malaysia. Sanyo would neither confirm nor deny the rumor but a spokesman says that if the company were to move, it would be because of Korea's rapidly rising labor costs and not due to any uncertainty over the country's political situation. He would not comment further.

Mum is also the word at Wang Laboratories Inc., headquartered in Lowell, Mass. When asked whether Wang was concerned about Korea's current economic and political environment, Chauncey C. Chu, manufacturing vice president, replied with the utmost diplomacy: "We made the decision to manufacture in Korea two years ago. If we were making the decision today, we probably may or may not have come to the same conclusion."

Other Americans are pooh-poohing the situation. Referring to the massive labor strikes last summer, Arthur W. Zafiropoulo, president of Drytek, a General Signal Corp. subsidiary, says, "We had the same thing here in the U.S. during the '60s." Adds James A. Hill, president of ECAD Inc., headquartered in Santa Clara, Calif.: "I think we're just seeing a short-term perturbation there." Consequently, Hill says ECAD will be investing more than $200,000 in Korea next year.

George B. Cobbe, president of Samsung Hewlett-Packard, is similarly nonchalant. When asked whether he was ever afraid for his family's personal safety in Korea, he replied, "Hell no." Then, pointing at the street below his 14th-floor Seoul office, he added, "It's more dangerous down there because of the way those crazy taxi drivers drive." Last summer, those cabbies were on strike; they refused to pick up any passengers. In a few days, they will be voting for their new president.

ALDEN M. HAYASHI

Editor's note: An exchange rate of 800 won = $1 was used in calculating dollar figures. Korea's presidential election is scheduled to be held before Dec. 20.

How some U.S. electronics companies have fared in Korea

	Sales ($ milions)		Date	
	1986	1985	founded	Employees
IBM Korea Inc.	$244	$202	1967	960
Motorola Korea Ltd.	239	204	1967	4,500
Goldstar Semiconductor (owned 44% by AT&T)	215	179	1976	3,000
Fairchild Semiconductor Korea Ltd.	56	36	1966	700
Korea Xerox Co.	52	39	1974	1,321
Goldstar Honeywell Co.	16	9	1984	236
Samsung Hewlett-Packard	16	10	1984	286

Source: *B. K. Electronics* magazine

CAE/CAD

Whatever happened to the silicon compilers?

They used to say that silicon compilation would make every engineer a chip designer. It still might happen

Whatever did happen to silicon compilers? They were the "expert" software systems that would allow engineers with no silicon background to design chips. Three years ago, market watchers were predicting that compilation would dominate custom chip design by 1990. All computer-aided design/engineering companies would have to offer compilers, or become also-rans.

It hasn't quite happened that way. The original "Little Three" vendors of silicon compilation — Silicon Compilers Inc., Seattle Silicon Technology Inc. and Silicon Design Labs — failed to meet venture capitalists' hopes that they would emulate the hypergrowth of the "Little Three" of CAE — Daisy Systems Corp., Mentor Graphics Corp. and Valid Logic Systems Inc. And the market remains small. San Jose-based market research firm Prime Data Inc. tabs compiler sales at $48 million this year, and estimates they should reach $180 million by 1991.

In theory, silicon compilers make chip experts out of systems designers. The engineer sets the architectural or behavioral characteristics of the circuit using functional blocks. These blocks may be as simple as multipliers or chunks of memory but could also be entire microprocessors. The software then "compiles" the blocks, automatically laying them out physically and routing data pathways.

The original silicon compiler vendors are much different companies than they were three years ago. Silicon Compilers merged in March with Silicon Design Labs to form Silicon Compiler Systems Corp., which San Jose market research firm Dataquest Inc. says now owns the market. Seattle Silicon dropped the "Technology Inc." for "Corp.," tossed its founder, and now hopes to act equally as a design broker — designing chips and buying time on vacant fabs — and a seller of software. Other candidates for the compiler throne had included Lattice Logic Ltd., bought by chip maker European Silicon Structures, and MetaLogic Inc., now defunct, according to analysts. So the question is not what happened to silicon compilers, but what happened to the silicon compiler companies.

Spreading the gospel

Explains Sam Brown, chief operating officer for Seattle Silicon of Bellevue, Wash.: "There was confusion between a market and a technology. . . . Lots of people are using the technology, but the technology isn't a business. . . . In all honesty, there is a lot of hype with start-ups."

Phillip Kaufman, chairman and chief executive of Silicon Compiler Systems of San Jose: "With the exception of MetaLogic, which was way out on the fringe, everybody is still here. . . . The industry has been forecast to grow very fast and it has grown very fast. The big thing that happened was that the larger companies that were talking compilers — GE, Calma, Mentor — well, if they're still doing it, they've totally internalized it. On the other hand, VLSI Technology and LSI Logic have totally embraced the technology. There has been some backlash. Silicon compilation got a lot of press and there was a lot of hype."

Indeed, the two biggest U.S. custom chip houses, LSI Logic Corp. and VLSI Technology Inc., do use compilation. VLSI Technology's director of design technology, James Rowson, claims he was compiling long before Silicon Compilers offered its first commercial product in late 1984. "Compilers are a natural thing for an ASIC company to do," Rowson says, referring to application-specific ICs, a euphemism for custom chips. So natural, in fact, that VLSI, which used to serve as a foundry for Silicon Compilers, now deems that arrangement too competitive.

"Our mask designers now are only building compilers," Rowson continues. "The object is to do the minimum amount of custom layout possible." He concludes: "Absolutely, the future is going to be full of compilers. As a business, I'm not sure of it, but as a technology, it's right on."

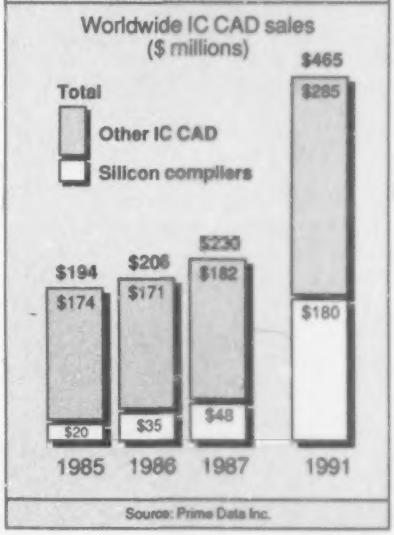
General Electric Co.'s CAD subsidiary, Calma Co., did have a compiler project underway, Gary Leive, Calma's director of IC system development, confirms that "Socrates," its compiler, originally came out of GE Semiconductor's R&D, before Calma moved in. But when Calma consolidated its operations, the North Carolina project spun off on its own. Leive says GE still has some corporate research going on. He declines to say how much GE and Calma invested.

Silicon compilation "has proven to be a difficult problem for a variety of companies that focused on that completely," Leive says. "It has been disappointing to the people who hoped to eliminate custom design."

Tight-lipped

Seattle Silicon and Silicon Compiler Systems are both private, and both tight-lipped about their finances. Seattle Silicon claims to be profitable, but the only thing chief operating officer Brown will say about sales is that he recently booked $700,000 worth of orders in one month. Dataquest says SCS is near profitability, but the two have soaked

Silicon compilers are the fastest-growing IC CAD segment



Source: Prime Data Inc.

up nearly $50 million in venture capital between them.

Seattle Silicon just closed a $3.85 million round of financing and is looking for more. It has a $7 million R&D partnership with a Prudential-Bache Securities Inc. division, not to mention a $7.5 million "strategic partnership" with General Motors Corp. Last fall, Hambrecht & Quist Venture Partners's Stewart Carrell resigned a spot on VLSI Technology's board to run the company. He's looking for a full-time president.

Brown says the company has "changed strategy pretty dramatically" in emphasizing design brokerage as much as it does. He figures to latch on to medium sized runs — 5,000 to 10,000 chips a year — and leave the heavy stuff to the merchant semiconductor companies. He has support deals with National Semiconductor Corp., NCR Corp., Ricoh and United Technologies Microelectronics Center Inc. "Almost any semiconductor company will sell foundry service — it's like the last 10 seats on an airplane," Brown says.

It was either that or be a tools-only vendor. Brown says that SCS is "becoming more of a CAE company. The path they've set for themselves will put them in competition with Mentor and Valid."

Daisy's director of ASIC marketing, Robert Dahlberg, doesn't see SCS as a competitor. "They realize the need to coexist in design environments and are not going to try to displace Daisy or Mentor," he says. Daisy used to resell systems from Silicon Compilers. "We sold a few. It was not a wildly barn-burning success," Dahlberg admits. "Maybe people were buying it so they could say, 'Hey, we've got a silicon compiler — we're on the leading edge.' " But the agreement collapsed after Daisy dropped the proprietary workstation the system was running on.

Neither does Mentor feel heat from SCS, according to Frederick Cohen, director of marketing for IC layout tools. Mentor at one time or another had marketing ties to each of the compilation Little Three. Cohen says Mentor also put together a business plan to look at making a compiler of its own, but opted not to. "I don't think the silicon compilation market is stable yet," Cohen cautions. "I'm not convinced that a year from now we won't see further changes."

DAVID CARD

OPTICAL INSPECTION

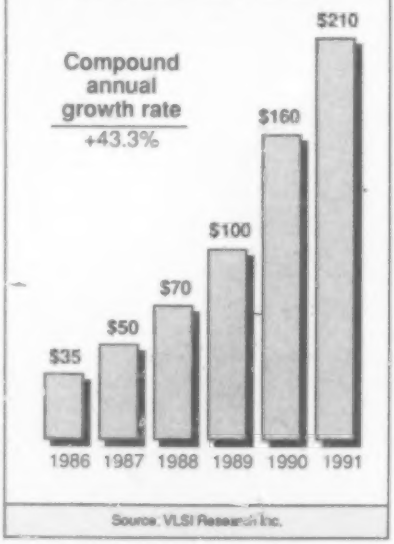
Close inspections of the semiconductor kind

KLA remains the "sun king" of automated semiconductor wafer inspection, but newcomers want to turn out the light

Once upon a time, in the realm of automated wafer inspection, KLA Instruments Corp. was king. For two years, this builder of peopleless systems for inspecting semiconductor wafers ruled the perfect niche — one with little opposition. But, like many a monarchy, this one is being challenged. There are a number of knavish newcomers afoot, releasing or about to release new machines that promise to be faster, smarter or better than the king's. Today, the contenders are milling about Silicon Valley preparing for the battle that will certainly ensue.

All are hungry for the spoils. The market for image-processing systems used in wafer inspection is currently worth about $35 million worldwide, according to VLSI Research, a market research firm based in San Jose. These systems inspect silicon wafers during various stages of fabrication. Some look for process defects. Some perform the task of critical dimension measurement. And others, like KLA's equipment, do both.

In wafer inspection, image-processing systems are hot



Undisputed monarch of this market is KLA, whose first automated wafer inspection product, the 2020 model, hit the streets in early 1985. Since then, the Santa Clara, California-based equipment vendor, "has just walked away with the market [. . . capturing] about 90% of the total," says G. Daniel Hutcheson, director of VLSI Research.

And, Hutcheson believes, KLA "seems poised to capture" even more of this market — which is forecast to grow at an average annual growth rate of 43% through 1991. Indeed, KLA's head start advantage is increasing. Several months ago, the company announced second-generation wafer inspection systems that promise to be four to 15 times faster than its 2020 model and which are scheduled to hit the streets during mid-1988. The company is also beginning to enjoy follow-on orders, a sure indication that market acceptance of its products is gaining. So how can the newcomers — the smaller and/or less entrenched companies — compete?

The answer is: by picking a niche or a different focus, or by making a machine that is faster or cheaper. Those nipping at KLA's heels include vendors such as Cambridge Instruments Inc., E. Leitz Inc., Siscan Systems and Britain's Vickers Instruments as well as the Instrument Group of Japan's Nikon Inc. Although these vendors do not go head-to-head with KLA — their equipment requires operators, does not perform all of the functions of the 2020 family, and can cost approximately $100,000 to $500,000 — their machines are used for wafer inspection. Another supplier, Lasertec USA Inc. of Japan, formerly NJS, has shipped 15 to 20 systems compared with

KLA's installed base of about 50 machines. However, none of the Lasertec units is installed in the United States, and according to VLSI Research's Hutcheson, they pose little threat to KLA.

There are, however, contenders that promise to attack head-on. Their equipment will be price-competitive and, although it may not perform all of the functions of KLA's 2020 family, it is expected to spur some interesting maneuvers over the next several years.

Daring to be different

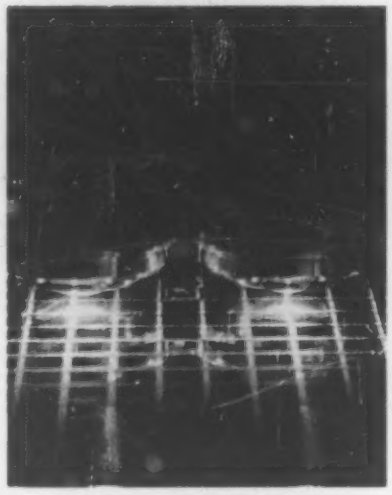
"The real sleeper could be Insystems," says Hutcheson of VLSI Research. San Jose-based Insystems points out that while the competition's equipment must inspect the good with the bad when looking at a wafer — which takes a lot of processing power and precious time — the Insystem machine shows up only the defects. "We decided to do things differently, and not follow the rest of the pack," says George Canavan, Insystems' vice president for marketing. While this approach gives Insystems a speed advantage, the technology limits its use to wafers with highly repetitive patterns, such as on memory chips.

Another contender, Optical Specialties Inc. (OSI), in Fremont, Calif., already has a well-established presence in the market for semiautomatic wafer inspection tools, which automate the wafer handling but require operators with high-powered microscopes to perform the actual inspection. In addition to being price-competitive with KLA — hoping to keep its product under $1 million — the company also hopes to beat the giant in terms of accuracy, according to John Dralla, product marketing manager. However, OSI's product is far from coming out the door. The current schedule calls for beta-site testing at the end of this year, and shipping by mid-1988.

Although there are advantages to coming out after the pioneer, there are also some pitfalls. KLA has "developed the market and brought the customer up the learning curve," says Dralla. But now that customers are coming up to speed, there are worries that the window of opportunity might narrow before OSI begins shipping. "We could be affected by a late entry. It's a concern of ours," notes Dralla, who estimates that his company will sink about $8 million into this product before shipping.

Not to worry. According to Stephen Balog, an analyst with Prudential-Bache Securities Inc. in New York City, that window will be open for some time. The market will eventually be "huge" he exclaims, with enough room for anybody that can make a machine that works. On the downside, however, Balog also predicts that "there'll be more failures than successes." In fact, several automated wafer inspection start-ups have already foundered.

Despite this bleak picture, KLA's challengers believe there is great reason to forge ahead. Advancements in semiconductor technology — line widths that are rapidly shrinking to submicron levels, wafers that can contain 20 or more layers of processes, and wafer diameters that are getting larger all the time — are pushing the need for machines to perform tasks that are exceeding the limitations of the human eye. Consequently, there's a growing need for test equipment that is "faster, smarter and can look at smaller things," points out Peggy Wood, research analyst at Dataquest Inc., a market research firm in San Jose.



KLA's reticle and photomask inspection system can detect quarter-micron flaws

Expensive exotica

But such exotic machines are not cheap. With price tags in the million-dollar range, purchases are limited to buyers with deep pockets. They are also restricted to use only on the leading edge of production lines. While human inspectors can discriminate down to about 30 defects per square centimeter, according to Patrick Lamey, vice president for marketing at KLA's wafer inspection division, the customers buying his kind of equipment are those looking for detection of flaws at one-hundredth of that density.

Indeed, "the people in the bunny suits have to go," says Balog, referring to the operators that use high-powered microscopes to perform critical dimension and process defect testing. While manual systems might be adequate for mature product lines — such as chips with 2-micron line widths or 64Kb DRAMs — they are not up to the task of inspecting extremely dense submicron logic chips or 4Mb DRAMs.

For now, however, semiconductor manufacturers are limiting their use of the million-dollar machines while continuing to invest in the lower priced equipment which offers increasing automation of wafer handling, but is still operator-dependent. For example, chip manufacturer VLSI Technology Inc. is currently spending heavily on capital equipment while retrofitting the fab facility at its San Jose headquarters. This company is also building a new fab with a Class 1 clean room in San Antonio, Texas.

Describing the utilization of the mid- to high-end products, Perry Denning, operations manager at the San Antonio facility, uses a motoring analogy: "You can sit in heavy traffic in a Ferrari, or you can sit in a Chevy and still get to the same place at the same time." The relative lack of speed, as well as the cost of purchasing and then the support of the "Ferraris" makes them "prohibitive to use in an in-line fashion," says Denning.

Instead of placing their KLA inspection machines in "traffic," VLSI has purchased them (one each for its San Jose and San Antonio fabs) for use as engineering tools — for yield enhancement and to pinpoint defects and problems that are a part of the process flow, says Denning. Meanwhile, the "Chevys," or semiautomated equipment, sit in the traffic flow of the wafer fab. Despite the limitations of the "Ferraris," Denning says that the payback, due to yield increases, is less than 18 months, and in some instances can be a lot shorter than that.

CAROL SUBY

SEMICONDUCTORS

1Mb DRAMs: Users scramble to get them

They're new, they're hot, and they're in short supply already. The memory chips are giving both users *and* vendors grief

Start with a popular memory-chip product. Add production problems, international trade disputes, patent infringements and politicians, and the result is chaos. Add a voracious user community waiting to gobble up everything produced and suddenly supply and demand are way out of balance.

There is a worldwide shortage of 1Mb DRAMs in the market today, and most analysts agree it could continue until the end of next year. This shortage, despite its severity, has done at least one good thing: it has reminded large vendors that there is money to be made in commodity memories.

But being a buyer in a seller's market is not very pleasant, and users today are finding vendors sold out of 1Mb dynamic RAMs through the first, second, and even third quarter of next year. And the prices are high.

According to Dataquest Inc., the DRAMs to peak by 1990 at 750 million units and to drop off after that. However, the current shortage may drag that time frame out some, says ICE's market research manager William J. McLean. For comparison, 4 million 4Mb chips will be produced in 1989, jumping to 300 million by 1991.

Supplying the bulk of that demand are five major companies, four of which are Japanese. The Japanese companies, Hitachi Ltd., Mitsubishi difference between supply and demand is wide and getting wider. Production of 1-megabit chips worldwide is expected to be around 50 million pieces by the end of the year, while demand will be closer to 60 million, the San Jose-based market research firm reports.

Another chip market watcher, Integrated Circuit Engineering (ICE) of Scottsdale, Ariz., expects 1Mb Electric Corp., NEC Corp. and Toshiba Corp. will have a 77% share of the market by the end of 1987, according to ICE. Texas Instruments Inc., the only major U.S. supplier, is predicted to have a 10% share of the market by the end of this year. Micron Technology Inc. is the only other U.S. maker of the big memory chips.

Yet all of these companies are unable to keep up with the burgeoning demand for 1Mb chips. Computer, consumer and telecommunications applications are leading the charge for 1Mb chips, and demand is also being fed by the fast, new 32-bit microprocessors such as Intel Corp.'s 80386.

Users, who want to take advantage of the market upturn, are trying to design in more memory and features into new products. Hewlett-Packard Co., which is using 1Mb chips in its reduced instruction set computing (RISC) Spectrum computers, says it has suffered from the shortages. "We continue to be subjected to shortages of 1Mb products and we see no end in sight for the next three to six months," an HP spokesman says.

Unhappy chip makers

Even the chip manufacturers aren't very happy about that. "I would much rather be selling product than controlling my order entry and putting customers on allocation. There is no [1Mb] availability for anyone

Europe's megabit maelstrom

Sales of one-megabit chips are booming in Europe as computer and telecommunications manufacturers bid for limited supplies. Siemens AG and NEC Corp. are the only firms with full-fledged fabs at present. But Hitachi Ltd. and Toshiba Corp. are testing and assembling devices they are shipping from Japan. And some time next year, N.V. Philips GL is likely to begin manufacture, at Nijmegen, Netherlands, of its own 1Mb static random access memory (SRAM) chip.

Megabit chips are clearly a good business to be in right now in Europe. Although the price dropped from $24 at the start of the year to $15 in August, it rose to $18 in September. The demand is also affecting the pricing of 256-kilobit memory chips, which cost $1.70 in January and now go for $3.

Jim Beveridge, director of the European Semiconductor Service of market research firm Dataquest Inc., says: "The European success of the 1Mb chip is closely linked to the recent takeoff of surface mount technology for semiconductors. For the past five years, industry specialists had been claiming that SMT was just around the corner. It was like crying 'wolf' — because those claims never materialized. Now that surface mount has really happened, Europe's semiconductor industry is not ready to cope."

Prudence dictated the strategy that has left the European manufacturers unprepared for surface mount. Reluctant to risk heavy investment in the new technology, they produced designs and handed them over to subcontractors to produce. "Now the subcontractors are inundated," says Beveridge.

Siemens, using technology obtained from Toshiba, began producing its 1Mb DRAMs at a plant in Regensburg, Bavaria, earlier this year and expects to build up to volume levels by Christmas. NEC also prototyped its chip at the beginning of 1987 at a facility in Livingston, Scotland. It is now manufacturing in volume.

Hitachi, whose 1Mb chip test and assembly plant is at Braunschweig, Germany, and Toshiba, which tests and assembles at Landshut, Germany, are likely to build full-scale fabs to meet the demand.

JACK GEE

in the fourth quarter. We are not accepting any new orders for delivery now until the third quarter of 1988," says Robert Merritt, Hitachi America Corp.'s memory marketing manager.

Other users, like Wyse Technology's PC marketing manager Christopher Kryzan, say there is a 50% to 80% price premium for using 1Mb chips compared with the price that four 256-kilobit chips, offering the same amount of memory, would command. "We want to wait until the price is closer to break-even," Kryzan says.

Waiting is something that vendors want users to avoid, since the severe 1Mb shortage could make users decide to hold off until 4Mb chips are available late next year. In the meantime, some vendors believe that these buyers will continue to use 256K chips. That could leave 1Mb chip vendors out in the cold as they ramp up to find that demand has gone elsewhere.

> The severe 1Mb DRAM shortage could make users decide to hold off until 4Mb chips are available late next year

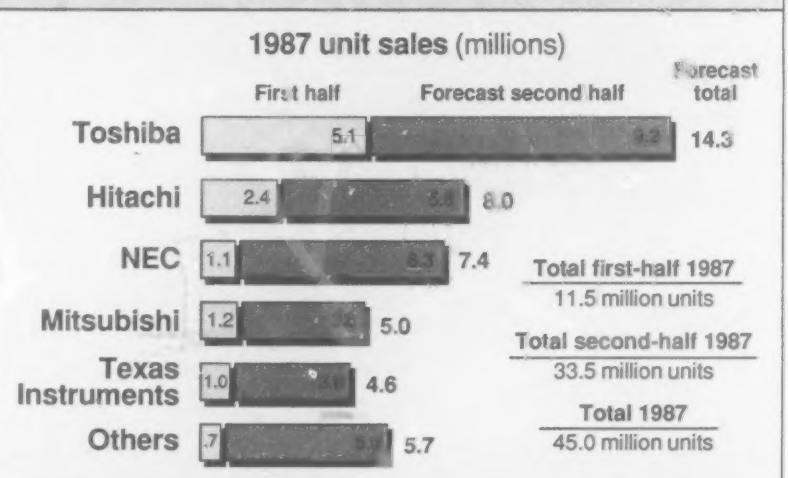
Unfortunately for users, 1Mb DRAMs will continue to be elusive commodities well into next year. If this were a clear-cut case of free market supply versus demand, the length of the shortage might be easier to forecast. As it is, an intricate fabric of politics, international trade issues, and technological challenges is lurking under the guise of a DRAM shortage. The most popular scapegoat, without a doubt, is the U.S.-Japan trade agreement, which calls for production limits on DRAMs shipped into the United States.

"We stepped on our own faces," declares Jack Beedle, president of Scottsdale, Ariz., market researcher In-Stat Inc. "The 1Mb market is whatever Japan's Ministry of Industry, Trade and Information says it is going to be. We all cried that we couldn't compete, and then there were the embargoes. The Japanese are storing parts in warehouses, and prices go up and demand goes up. This is hurting American buyers. In the long run this has benefited the Japanese."

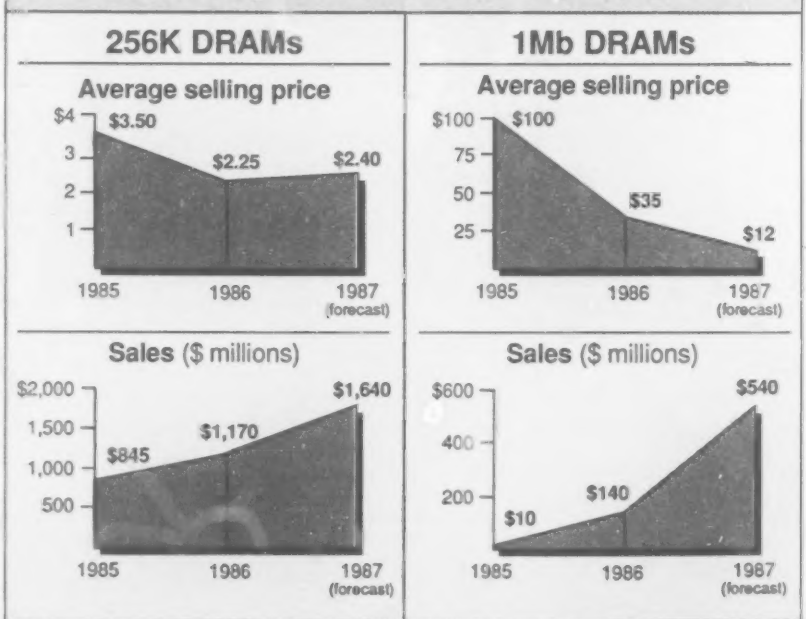
Yet most Japanese manufacturers say that the shortages are caused not by MITI, but by problems in yield that have slowed the ramp-up process. Hitachi's Merritt says that the quotas will not have an impact on his company, insisting that it is more a matter of yield and ramp-up than MITI guidelines.

But ICE market watcher McLean feels that the MITI interference has dragged out the peak times — the length of time between a product's introduction and its peak sales levels — for DRAMs, which had dropped to two years during the period of

Rapid ramp-up: Top 1Mb DRAM makers are racing to keep up with demand...



...and prices for both 256K and 1Mb DRAMs fall fast as dollar volume builds



Source: Integrated Circuit Engineering Corp.

changeover from 16K chips to 64K chips. Once MITI entered the market, three years became the standard peak time for products once again.

"The market is way out of whack," says McLean. "There could have been two times as many units in production this year if MITI had not gotten involved. MITI has gained power in this situation. The Japanese believe they have leverage over the trade agreement. But what are you going to do? If you let production go you get the gray market again."

Upset Japanese

But most Japanese companies seem equally upset at the MITI involvement. Toshiba Semiconductor Corp., which single-handedly accounts for 32% of the 1Mb market, entered into discussions with MITI, trying to raise the ceiling on 1Mb production. Toshiba is currently the only company which has reached the ceiling, according to vice president and general manager Robert Brown.

MITI raised the 1Mb export-quota ceiling for all of Japan's chip exporters from 6.9 million units for the third quarter of 1987 to 14.0 million for the fourth quarter. But, says Toshiba's Brown, "that really doesn't make things any easier. We can now build up capacity more, but we won't be able to take advantage of that until next year. I don't think our fourth-quarter allocation numbers will be met."

Most Japanese chip makers say the shortages are caused not by MITI, but by problems in yield that have slowed the ramp-up process

Many analysts fret that politics may play an even more worrisome role in tightening supply lines. Because of Toshiba's sales of milling machines to the Soviet Union, some members of the U.S. Congress are agitating to ban Toshiba from selling any products in the United States. If Toshiba were to go away, not only would Motorola Inc. lose its 1Mb supplier, but U.S. buyers would lose access to almost 32% of total production.

The political situation may also affect how quickly companies come to market with product, which is another facet of the shortage. One-megabit chips have been slower to ramp up than their predecessors, and one explanation bandied about today is that the Japanese have been discouraged from entering another controlled U.S. market. "Would you put your best people on product development in an area that is going to be restricted in production and in free market pricing?" one industry player asks, noting, "it hasn't been a top priority for us."

Others in the industry say that the fair market value pricing (FMV) structure, which rewards the largest manufacturers — in this case, Toshiba — provided inadequate incentives for other Japanese companies to play in the market because Toshiba had such a large lead. Now that it would behoove these companies to ramp up, they are too far behind, and will take some time to get up to speed.

An artificial shortage

The 1Mb shortage isn't helped by the current shortage of 256K chips, either. According to Dataquest analyst Victor DeDios, there is an artificially created shortage of 256K chips, which is particularly acute for those with special packaging or high-speed requirements. Says DeDios: "What's really causing this shortage is production controls of these chips created by the trade agreement." Compounding the abbreviated production is the greatly increased demand for these chips.

Several Japanese companies, including NEC and Hitachi, are booked on 256K semiconductors through the first quarter of next year. They anticipate continued shortages of chips as users, unable to get the larger 1Mb chips, reach for the 256K units. In fact, DeDios is forecasting that 256K chips are going to stay strong through 1988, contradicting previous beliefs that the 1Mb chips would supplant them next year.

As if that weren't enough, Korean giant Samsung Semiconductor has recently run afoul of the International Trade Commission (ITC), thanks to its reluctance to settle a patent infringement suit filed by TI. The ITC is recommending an exclusion order on Samsung's 64K and 256K chips and all equipment containing those parts. If President Reagan agrees to the ITC's recommendation, U.S. chip buyers could stand to lose one of this country's top five 256K suppliers. Another loser in this arrangement could be Intel, which has an agreement to sell Samsung's memory chips — including an as yet undisclosed 1Mb memory chip. Intel appears undaunted, however: "It's business as usual," says a spokesperson.

If Toshiba were banned from selling in the U.S., Motorola would lose its 1Mb supplier *and* U.S. buyers would lose access to almost 32% of total production

Perhaps the bottom line on the shortages, if they can be separated from the international events surrounding them, is that new technology always takes longer to develop, produce, and reach volume with, than the engineers think it will. Despite accusations from both sides of the Pacific Rim about dragging of feet, stockpiling and price inflation, the truth may be that 1Mb DRAMs are just very difficult to produce in volume over a short period of time.

Why are producers taking so long to ramp up? More complex technology is most often the answer. State-of-the-art fab capacity is required, and the geometries are smaller as well. TI, for example, is shipping a 1-micron 1Mb chip now. Also, the 1Mb chip is really stretching the existing 256K technology, engineers say. TI and NEC chose not to work with existing production methods but instead went with their own "trench" technology, a three-dimensional technique that permits much greater chip densities. And development of such a new technology always takes longer.

NEC, which is just now entering the 1Mb market, says it has taken its time for a good reason. "We are planning for the future," says John Marck, vice president and general manager of Memory Products Division. "It's taken quite awhile to develop our trench technology, but it is the acknowledged technology of the 4Mb chip, and we will have a jump on the future."

VALERIE RICE

KEEPING AMERICA COMPETITIVE

CELLULAR PHONES

Calling all competitors: Motorola just got tough

Motorola flexed legal muscle and manufacturing might to win back cellular phone supremacy — so now Japan makes phones in the U.S.

By Norm Alster

Cellular mobile telephones have begun to revolutionize personal and business communications. But the cellular telephone manufacturing industry itself has undergone tumultuous change in the past two years. Catalyst for much of that change — directing the flow of events both publicly and behind the scenes — has been . . . pioneer Motorola Inc.

Motorola is not the powerhouse it used to be in the cellular phone business. But it is the major U.S.-headquartered survivor in the industry and in the past year it has more than held its own among three or four tightly bunched U.S. market leaders.

Motorola executives proudly credit their recent market success to new manufacturing efficiencies and quality improvements. With laudable gains in inventory turns, cycle time and defect-free product, Motorola's manufacturing efforts can rightfully claim a role in the cellular division's performance.

But there is a lot more than cycle time to Motorola's story. Aggressive legal and political tactics have been every bit as important in enabling the company to stay competitive in a market targeted by virtually all the Japanese electronics heavyweights. Never the silent suffering type, Motorola has complained long, hard and bitterly about Japanese trade practices. But more recently, Motorola's twitching and moaning have been backed up by effective action. The company has turned to its lawyers, the U.S. government and the courts to protect its market position and intellectual property.

In so doing, Motorola has saved its own cellular business and also turned the entire cellular industry upside down. The cellular phone business today bears little resemblance to that of 1984. Whereas just three years ago, Japanese manufacturers were drowning U.S. manufacturers in a flood tide of exports, today almost all manufacturing of cellular telephones is either based in the United States — or headed that way. And many of Motorola's most powerful overseas rivals now pay tribute to the pride of Schaumburg, Ill.

ELECTRONIC BUSINESS *has learned that several major Japanese manufacturers have agreed to pay royalties to Motorola in order to duck patent infringement charges. Firms which have refused such payments now face Motorola lawyers in court. This is the story of an American company that has learned to play industrial hardball.*

It was a grim situation that faced Motorola in the fall of 1984. Cellular telephone prices were in free-fall as Matsushita, Mitsubishi, NEC and others struggled to unload bulging inventories in what was then a slowly developing market. Prices were in "a terrible spiral downward," according to Eric Nelson, an analyst with the U.S. International Trade Commission. They were falling so fast, Nelson ex-

PAPER CHASE: Motorola's legal onslaught has generated a blizzard of documents. Among the claims filed against competitors were anti-dumping petitions to the U.S. International Trade Commission and Commerce Department.

plains, that customers simply stopped buying on the expectation that prices would be lower the next week. Almost invariably, they were.

In November of 1984, Motorola filed petitions with the U.S. International Trade Commission and the Department of Commerce, charging Japanese manufacturers with dumping cellular telephones in the United States. "The Japanese manufacturers are apparently intent upon taking over the U.S. cellular mobile telephone market, no matter what it takes. . . . Virtually all of the prices charged by Japanese manufacturers are at less than fair value," Motorola argued in its antidumping petition.

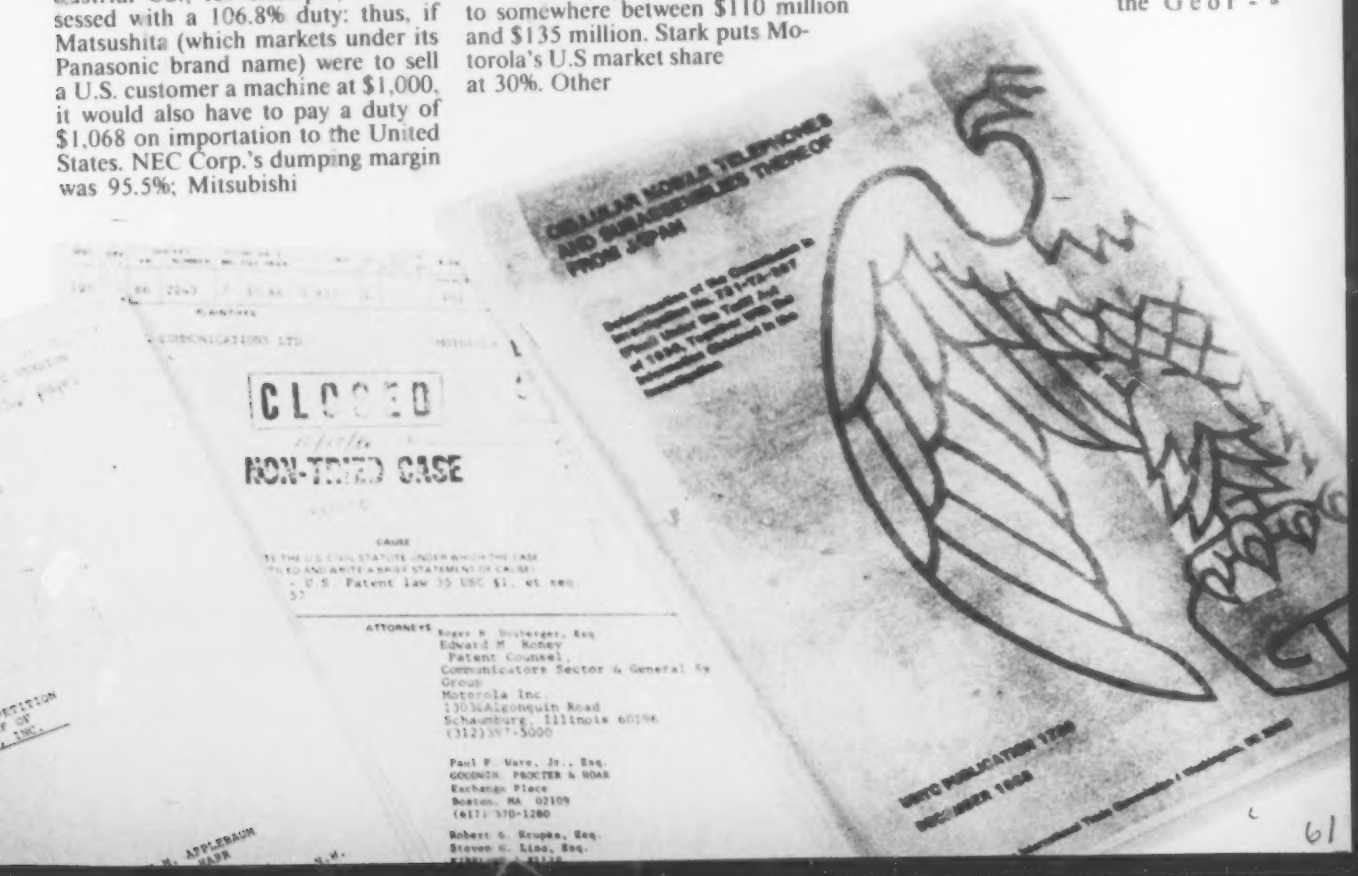
The International Trade Commission supported Motorola's contention that U.S. industry had suffered harm and the Department of Commerce, after concluding that the Japanese were selling cellular phones in the United States at significantly lower prices than they were selling them in Japan, imposed duties on Japanese product. The penalties were stiff. In some cases, they approached or even exceeded the prices for the telephones themselves. Matsushita Electric Industrial Co., for example, was assessed with a 106.8% duty: thus, if Matsushita (which markets under its Panasonic brand name) were to sell a U.S. customer a machine at $1,000, it would also have to pay a duty of $1,068 on importation to the United States. NEC Corp.'s dumping margin was 95.5%; Mitsubishi

International Corp.'s, 87.83%.

As a result of these actions, prices began to stabilize. Although the ITC action came too late to revive the floundering cellular businesses of E.F. Johnson, General Electric Co. and Harris Corp., Motorola survived. And in the past year or so, Motorola has come on strong, either matching or exceeding industry growth rates of 20% to 25%. Michael Stark, an analyst with the San Francisco investment banking firm of Robertson, Colman and Stephens, estimates that Motorola's U.S. sales of cellular radios actually grew by 50% last year to somewhere between $110 million and $135 million. Stark puts Motorola's U.S market share at 30%. Other analysts put it closer to 20%. According to Dataquest Inc., the U.S. cellular telephone market has matriculated from $21 million in 1983 to $285 million this year and is headed for a projected $343 million in 1988.

The antidumping suit was clearly a boon to Motorola. It also had a chilling effect on a number of Japanese producers. NEC and Panasonic were particularly hard hit, falling from front-runner to distant also-ran status in the last two years. But these were only the more obvious consequences of the Motorola suit.

It is not often that whole industries experience continental shifts. Rarer still are shifts that carry industries from Asia to America. And yet today, Motorola's major Japanese rivals have either wholly transferred or are in the process of transferring their cellular phone production from Japan to the United States. Oki Telecom, by most accounts in the top four (along with Motorola, NovAtel Communications Ltd. and Toshiba America Inc.) of cellular manufacturers, builds all its cellular phones in Norcross, Ga. Oki actually exports the Geor-



Cover illustration: Gary Hallgren. Rights to Dick Tracy character: Tribune Media Services

gia-built phones to Hong Kong, New Zealand and Australia. Toshiba expects to meet all its U.S. market needs for cellular phones with U.S.-manufactured product by 1989. Mitsubishi and Panasonic claim to make all (except their duty-exempt portable models) cellular phones here: Panasonic in Chicago and Mitsubishi in a Braselton, Ga., plant that is expected to turn out 60,000 units a year. NEC manufactures in Hawthorne, Calif., and Hillsboro, Ore.

There have been rumors that some Japanese manufacturers ship cellular phone subassemblies to places like Singapore for assembly and duty-free entry to the United States. This subterfuge is called "trans-shipments" and Anne D'Alauro, U.S. Commerce Department import compliance specialist, cautions scofflaws that her department is "very much aware" of the problem. But it is unlikely that these amount to a substantial share of the radios sold in the United States. Actually, with the exception of the handheld portables (which represent perhaps 10% of the market and are exempt from duties) and Toshiba's current output (which will soon be switched to the United States) very few radios are still manufactured in Japan for sale in the United States.

OPERATIONS CHIEF EDWARD STAIANO (front) claims Motorola has been so successful in reducing parts count that its new radios have roughly half the parts of those made by Japanese rivals. **PRESIDENT JOHN MITCHELL** (rear) welcomes rival Japanese producers to the U.S. — as long as they're not subsidized

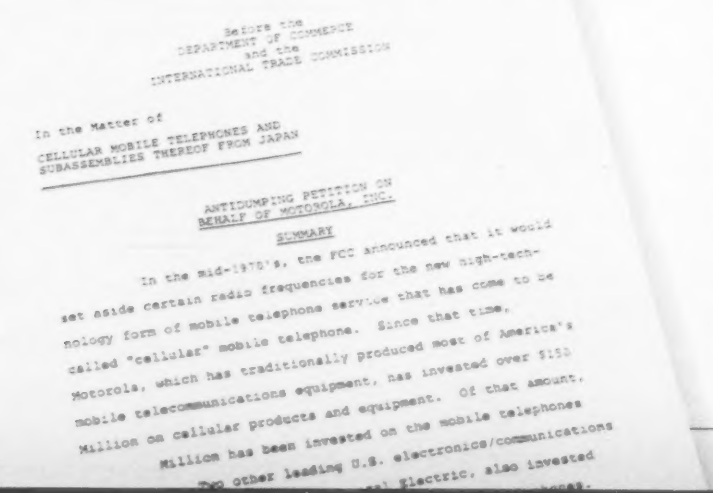
Skirting duties

By producing in the United States, the Japanese sk[illegible] the dumping duties. But there are other reasons Japanese firms have chosen to relocate manufacturing in the United States. According to industry insiders, foreign manufacturers were offered a choice by Motorola: either pay royalties or face patent infringement charges in court. Toshiba, for example, opted to pay the royalties. Interestingly, says Louis Antoniou, vice-president of the mobile communications division of Audiovox, sole U.S. distributor for Toshiba's cellular phones, the offer included a two-tier royalty schedule. Antoniou says the royalties on phones manufactured in the United States are "a little bit less than one-third as much as the royalty for Japanese production."

Toshiba vice president Ichiro Tajima says that one factor in his firm's decision to relocate manufacturing in the United States was the lower level of royalty payments. Tajima, while acknowledging that royalty payments by Toshiba to Motorola "have begun," would not disclose any details on the level of payments.

Oki Telecom vice president for marketing and strategic planning Anthony Russo reports that Motorola's approaches to Japanese companies "started well over a year ago. . . . They have gone to a few companies . . . I know they approached a few Japanese companies." Russo would neither confirm nor deny that Oki was paying royalties to Motorola. Motorola declined to name the companies it has licensed, although documents filed with the International Trade Commission reveal that four companies were licensed by Motorola between December of 1986 and April of 1987.

To put Motorola's actions in perspective, it is worth noting that its U.S. semiconductor brethren — nota-



Before the
DEPARTMENT OF COMMERCE
and the
INTERNATIONAL TRADE COMMISSION

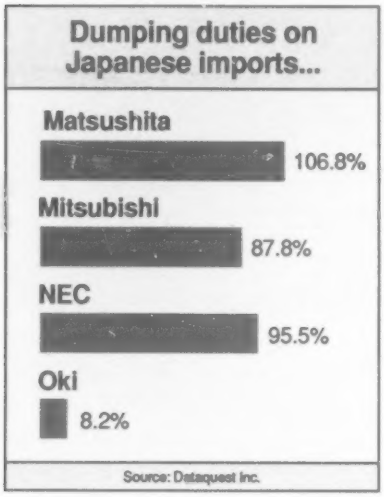
In the Matter of
CELLULAR MOBILE TELEPHONES AND
SUBASSEMBLIES THEREOF FROM JAPAN

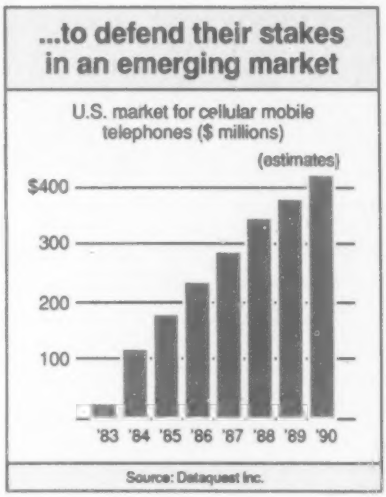
ANTIDUMPING PETITION ON
BEHALF OF MOTOROLA, INC.

SUMMARY

In the mid-1970's, the FCC announced that it would
set aside certain radio frequencies for the new high-tech-
nology form of mobile telephone service that has come to be
called "cellular" mobile telephone. Since that time,
Motorola, which has traditionally produced most of America's
mobile telecommunications equipment, has invested over $150
Million on cellular products and equipment. Of that amount,
Million has been invested on the mobile telephones
Two other leading U.S. electronics/communications
[illegible] Electric, also invested

Michael Abramson





bly Intel Corp. and Texas Instruments Inc. — have also shown stiffened resolve in seeking legal and governmental protection for what they deem to be proprietary technology. And the willingness of Japanese companies to agree to royalty payments may well reflect the merit of Motorola's claims. Although some Japanese executives claim these decisions are simply good politics — avoiding legal entanglement and adverse publicity at a time that the U.S. government and public show increasing impatience on international trade issues — they also issue from Japanese calculations on their chances of besting Motorola in court.

But why would Motorola assess U.S.-built product with lower payment levels than Japanese-built? Antoniou offers one explanation: "It's one way for Motorola to force the firms to come in to the U.S." Interesting, indeed. It's one thing for a company to publicly wrap itself in the flag. But could patriotic sentiment actually guide Motorola's hush-hush licensing negotiations? Not hardly, according to Antoniou. Motorola has a more practical interest in bringing the Japanese onshore. "That way Motorola will have a better chance to compete," Antoniou reasons.

Motorola president John Mitchell says he is unaware of any two-tier royalty schedule. But Mitchell does say that he is pleased to have the Japanese in the United States: "Frankly, we welcome that. We have found over the years that we can compete on a level playing field. If they're making product in this country. And we're making product in this country. And we're all buying components from around the world — that's about as level as you can make the playing field. As long as there isn't cost subsidization."

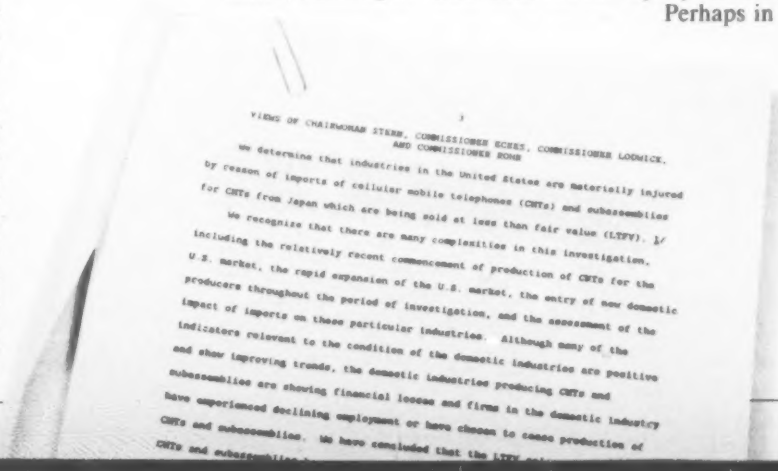
It will be interesting to see how competitive Japan's U.S.-based operations will be. Tomozo Yada, director of manufacturing at NEC America's Hillsboro, Ore., plant, claims NEC's U.S. efficiency is "the same as Japan — almost." Quality, too, is "almost as good" as in Japan. Toshiba vice president Tajima was asked if his company's cellular operations can manufacture as efficiently in the United States as it can in its home base? "To be honest with you, we don't know," he concedes.

Border dispute

But there is one foreign producer that Motorola has not yet managed to swing into the continental United States. That producer is Canadian — Calgary-based NovAtel Communications Ltd. — and it is now locked in legal battles with Motorola. In July, Motorola filed a patent infringement case against NovAtel with the International Trade Commission. Motorola, claiming it has been hurt by NovAtel, particularly in the low end of the U.S. market, asks the ITC to grant "a permanent exclusion order" on Novatel products. Another case in which the companies are trading charges and counterclaims is scheduled to be heard early next year in Chicago.

"Motorola approached us in March of 1986. They claimed we were violating a number of their patents. . . . They wanted us to pay royalties to them," recalls Delbert Lippert, president of NovAtel. Stephen Chow, attorney with Cesari and McKenna, the Boston law firm that represents NovAtel, says that NovAtel chose to go to court rather than to pay royalties to its cross-border rivals. "They were asking very large royalties," Chow contends. Lippert says NovAtel weighed the costs of litigation versus the costs of being licensed by Motorola. "The cost of the license was not cheaper than the cost of the litigation," says Lippert. Although Lippert would not disclose the actual royalty levels asked by Motorola, he does say that the U.S. company has held firm on its royalty demands.

Perhaps in an-


VIEWS OF CHAIRWOMAN STERN, COMMISSIONER ECKES, COMMISSIONER LODWICK, AND COMMISSIONER ZONE

We determine that industries in the United States are materially injured by reason of imports of cellular mobile telephones (CMTs) and subassemblies for CMTs from Japan which are being sold at less than fair value (LTFV). 1/

We recognize that there are many complexities in this investigation, including the relatively recent commencement of production of CMTs for the U.S. market, the rapid expansion of the U.S. market, the entry of new domestic producers throughout the period of investigation, and the assessment of the impact of imports on these particular industries. Although many of the indicators relevant to the condition of the domestic industries are positive and show improving trends, the domestic industries producing CMTs and subassemblies are showing financial losses and firms in the domestic industry have experienced declining employment or have chosen to cease production of CMTs and subassemblies. We have concluded that the LTFV

ticipation of patent infringement charges by Motorola, NovAtel went to court to invalidate two key Motorola patents. Motorola swiftly countersued, claiming violation of four of its patents. The rival claims will be adjudicated in the Federal District Court in Chicago. Also named in the ITC suit are Hyundai Electronics Industries Company Ltd. of Korea and Astec International of Hong Kong. These two firms assemble most of the transceivers (which account for 75% to 85% of cellular phone value) for the NovAtel phones. Having uprooted the Japanese cellular business, Motorola is now in a position to short-circuit nascent cellular operations in Korea and Hong Kong.

With Motorola's rivals either paying royalties or legal defense fees or pitching tents on a level playing field of Motorola's choosing, it would seem that the firm's legal tactics have been an unequivocal success. But this is not necessarily the case.

It is, after all, the free trader's argument against protectionism that ultimately the weak competitor will fail anyway. Indeed, artificial protective barriers such as duties are thought to discourage the sort of energetic self-improvement that is instigated by unfettered competition. But Motorola appears to be well aware of this trap.

One U.S. trade official who has been involved in a number of dumping cases says that many U.S. companies have won dumping battles only to lose the longer term competitive wars. Motorola, he says, has both won (cellular phones and tone-only pagers) and lost (display pagers) such cases, but has always managed to benefit from the nine- to 12-month price stabilization that all such dumping cases have historically provided. During that period of respite, the official

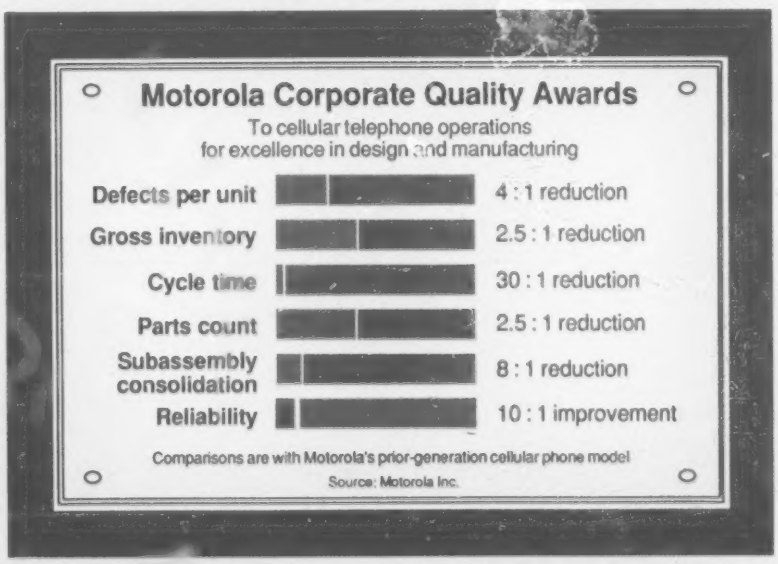
Scaling the Everest of quality

Motorola Inc. certainly had ample incentive to improve the quality of its cellular products. The company's early models had acquired a rather spotty reputation. Victor Spence, director of electronic data processing for Cellular One, a cellular telephone operator based in the Washington-Baltimore metropolitan area, says it was commonly known that Motorola "had quality problems" with its early units. Indeed, Susan Liebeler, vice chairman of the International Trade Commission (and the only ITC commissioner to vote against imposing dumping penalties) cited "the relatively high failure rate reported by some purchasers of Motorola's cellular mobile telephones."

But today even competitors acknowledge that Motorola's products have improved in quality. "I think they have a pretty good unit in terms of quality and reliability," observes Katsumi Fujii, general manager for the communications equipment sales division of Mitsubishi International Corp. Toshiba America Inc. vice president Ichiro Tajima describes Motorola as "price-wise competitive and quality-wise competitive." "Recently I don't hear any failures [of Motorola phones] reported," concurs Stacy Ogawa, assistant general manager for Panasonic Industrial Company's telecommunications division.

Motorola's top brass has recognized the accomplishments of the cellular phone operations. Three of 10 corporate CEO awards — Motorola's highest internal quality accolade — presented this year have gone to cellular. In designing its new Mini-Tac phone, the group was able to reduce parts count by 66%. In building the new units on a small lot just-in-time manufacturing line, cycle time was compressed by 98% and work-in-process levels flattened by 80%, according to Daniel Przybylski, senior manufacturing operations manager. Inventory is being turned five times as fast. "We're zeroing in on 20 turns," beams Edward Staiano, vice president of the General Services division that embraces cellular phones.

Like quality leaders Hewlett-Packard Co., IBM and Xerox Corp., Motorola has evolved its own mix-and-match formula blending the five core disciplines of quality improvement [ELECTRONIC BUSINESS, Jan. 15, 1987]. The emphasis is on implementing small lot manufacturing dependent on just-in-time supplier deliveries. Statistical process control and problem-solving methodology are applied to identify process problems and keep production within ever more tightly defined process parameters. Because the quality of supplied components must be very high, systems companies like Motorola have thinned supplier ranks, rewarding those that can implement suitable



THE CELLULAR DIVISION actually won three Chief Executive Officer awards — Motorola's highest internal accolade — for accomplishments summarized above

(who requested anonymity) explains, Motorola works hard to trim production costs.

Motorola executives contend that they have made this sort of progress in their Arlington Heights, Ill., cellular manufacturing operations (see accompanying article). In emphasizing design manufacturability and in implementing small lot short-cycle production, the cellular operations are said to have engineered impressive reductions in parts count, defect levels and labor costs per unit. The result is an operation which is "earning well," according to Mitchell. Vice president and cellular operations chief Edward Staiano, while declining to break out details on cellular's profitability, claims that "the corporation is very happy with our profit."

It's probably still too early to conclude that Motorola's manufacturing achievements have ensured its long-term leadership in a market that continues to attract powerful new participants each year. But the short-term picture is certainly in clear focus. Motorola can now enjoy the home-court advantage on a level playing field it has single handedly managed to bulldoze. □

If your company has received an award as a quality supplier, ELECTRONIC BUSINESS would like to know. If your company gives annual awards to its outstanding electronics suppliers, we would be interested in a list of winners. Awards should be for performance in 1986 or 1987.

Send details to:

Keeping America Competitive
ELECTRONIC BUSINESS
275 Washington St.
Newton, Mass. 02158

controls on their own product with bigger chunks of their business. Suppliers — as well as production personnel — are often involved in the early stages of product design to insure that the designs can be both produced and sourced as specified.

The highest quality

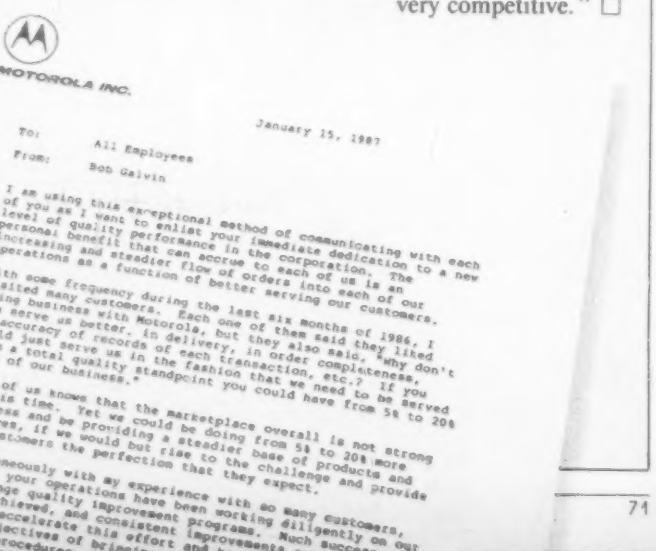
Motorola's corporate objective is to produce parts with a remarkable 99.9999998% conformance to specifications by 1992. This statistically derived Everest of quality is termed 6-Sigma. By contrast, at the sea level of 1-Sigma, which represents the standard deviation from mean, fully 32% of parts could be expected to fall outside specified parameters. Ten or 15 years ago, recalls Robert Carstens, manager of quality assurance for cellular phones, 3-Sigma was pretty much the standard in electronics manufacturing. At 3-Sigma almost 7% of parts fall outside specs. But the air is now getting awfully thin. Motorola president John Mitchell says that the cellular group is currently "very close to 5-Sigma (or 99.9999% conformance)."

Parts count reduction and equipment optimization have contributed to the cellular group's progress to date. Staiano claims that Motorola has been so successful in reducing parts count that the new Motorola radios have roughly half the parts of those made by Japanese rivals. Reduced part count has implications for quality. Since the number of defects in a system is a product of the defect levels in its components, lower parts count (so long as there is uncompromised component quality) should mean more failure-free systems.

Production managers in Arlington Heights, Ill. — where the radios are assembled — are proud of their ability to tweak performance levels of older equipment. "We did not fall into the trap when we started the program of simply going to the catalogs and buying the latest and the greatest," says Przybylski. Instead, older machines are coaxed to higher performance through hardware modifications, continuous software improvements and preventive maintenance. Przybylski estimates that most users of first-generation Panasonic surface mount component chip insertion equipment typically suffer placement misses on something like 800 of every 1 million parts. But the cellular group has cut down errors to "well under 200 parts per million." Przybylski says he buys new-generation equipment only when he's convinced that a machine "is running the best it's ever run and that we can't get it to run any better."

Staiano says one key to production performance is finding people at each station who are "in love with" their machines. Since love is precious but sometimes hard to find, management also enlists the aid of a more common commodity: self-interest. Worker compensation is based on the number of operations an employee has mastered. Because JIT production systems operate with low inventory and minimal work-in-process, it is important that production continues no matter who fails to show up for work. Hence, the value of employees with cross-functional expertise.

For all the apparent accomplishments in Arlington Heights, rumors persist that Motorola may move its cellular operations offshore. No way, says president Mitchell. If anything, he claims, cellular could serve as the model for more U.S. plants. "We see lots of opportunity to do more of the things we did in the cellular activity. And that is to build a focused, dedicated short-cycle factory in this country and be very competitive." □



MOTOROLA INC.

January 15, 1987

To: All Employees

From: Bob Galvin

I am using this exceptional method of communicating with each of you as I want to enlist your immediate dedication to a new level of quality performance in the corporation. The personal benefit that can accrue to each of us is an increasing and steadier flow of orders into each of our operations as a function of better serving our customers.

With some frequency during the last six months of 1986, I visited many customers. Each one of them said they liked doing business with Motorola, but they also said, "Why don't you serve us better, in delivery, in order completeness, in accuracy of records of each transaction, etc.? If you would just serve us in the fashion that we need to be served from a total quality standpoint you could have from 5% to 20% more of our business."

Each of us knows that the marketplace overall is not strong at this time. Yet we could be doing from 5% to 20% more business and be providing a steadier base of products and services, if we would but rise to the challenge and provide our customers the perfection that they expect.

Simultaneously with my experience with so many customers, many of your operations have been working diligently on our long-range quality improvement programs. Much success is being achieved, and consistent improvements are being made. We must accelerate this effort and bring our long-range objectives of breakthrough improvements as a regular procedure of performance

ATE

Schlumberger tests its new European ATE accent

Its record in electronics does not sparkle, yet Schlumberger claims ATE success in Europe. Same again, please, in the U.S.

By Jack Gee

Schlumberger Ltd., the New York-based oil and electronics conglomerate, has been in the news too often lately for the comfort of its management. Its name has rarely been visible in the headlines. But grim columns of print about the misfortunes of its subsidiaries are alarming stockholders.

Some of the most disconcerting news surrounds the electronics activities of Schlumberger, the world's largest oil-services company. Earlier this year, after being hounded by protests from the flag-waving U.S. computer chip industry and by President Reagan's administration, the company scrapped a plan to sell its Fairchild Semiconductor Corp. to Japan's Fujitsu Ltd. For awhile, it looked as if Schlumberger might be stuck with the dollar-draining chip maker. But then, National Semiconductor Corp. agreed to purchase Fairchild.

Schlumberger today has grounds for asking whether it made a major strategic error in getting into the chip business when, in 1979, it bought the already ailing Fairchild. Critics might ask whether the company was right to dabble in electronics at all: its records in automatic test equipment and CAE/CAD/CAM markets are nothing to write home about either. Kenneth Neff, vice president of San Jose market research firm Prime Data Inc., shows Schlumberger's share of worldwide ATE markets sagging: from a peak of 26% in 1979 to just over 13% last year.

But D. Euan Baird, 50, who was named chairman, president and chief executive of the conglomerate a year ago, clearly still has hope for his tester and CAD/CAM operations — especially in Europe, where Schlumberger executives lay claim to half of the chip-test segment as well as leadership in Britain's military board-test market. Shortly before the Fairchild sale, Baird set up a new management group — Schlumberger Technologies — to coordinate the company's test and CAD/CAM units.

MICHEL GOUILLOUD is the lucky executive in charge of Schlumberger's electronics interests. He wants the group to perform as well in the U.S. as he says it does in Europe

> In Europe, Schlumberger executives lay claim to half of the chip-test segment

The new group is headed by corporate vice president Michel Gouilloud from headquarters in Sunnyvale, Calif. The France-born manager, who has spent 30 years with Schlumberger, runs a mini-empire that spans Sentry, which specializes in test equipment for semiconductors and integrated circuits; Factron, whose technology is applied to testing printed circuit boards; and Applicon, which produces software and hardware for computer-integrated manufacturing (CIM). Gouilloud is also responsible for Benson, a leader in computer-graphics hard copy equipment for plotting integrated circuits and printed circuit assemblies, and for Schlumberger's instruments companies, Solatron, Adret Electronique and Enertec. The bulk of this trio's activities is concentrated in Europe.

Also under Gouilloud's direction are the Schlumberger Research Laboratory, at Palo Alto, Calif., which de-

velops new technology for all these products, and Nissec, which provides sales, service and support in Asia for Schlumberger Technologies.

Gouilloud would like to see Schlumberger Technologies perform as well in the United States as in Europe, where he claims that Sentry and Factron together control 30% of overall ATE equipment sales. He reports that Sentry is now breaking even in the United States, although it still faces a long haul before rivalling its performance in Europe, where he describes it as "super profitable." He adds: "Factron and Applicon are also profitable in their European markets. In Asia — except for Japan — all the companies of our Technologies division are profitable. And, in the U.S., they are picking up after a lengthy period of sustained losses."

Observers give the Gouilloud group a chance. Neff of Prime Data says: "In putting all its ATE activities under one person, Schlumberger can expect to give this sector of its business more weight and better synergy. It can look forward to better utilization of its resources — and this certainly will not hurt."

Gouilloud endorses this theme enthusiastically. "The new organization will enable us to marshal our resources more effectively. It will work in complete synergy with the other units of our company," he says. It's not the first time that the industry has heard that. Schlumberger Technologies had a predecessor: in late 1983, the corporation created the Computer Aided Systems group to do much the same thing, but CAS never produced startling successes.

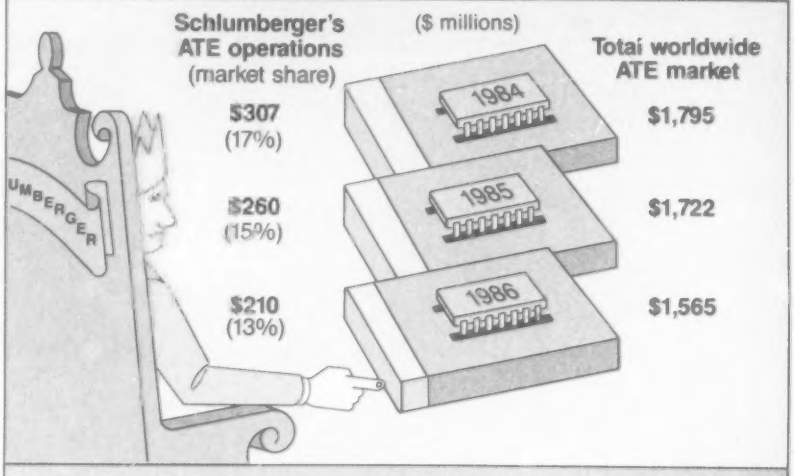
Centralizing production

Schlumberger Technologies comes with one tangible difference: a $35 million Advanced Manufacturing Center that will centralize the production of the ATE operations in one facility instead of three. Industry analysts view this as a signal that Schlumberger's ATE units are not as profitable as they make out to be. Says Stephen Balog, who follows this sector for Prudential-Bache Securities Inc. in New York City: "They can't be doing real well, or they wouldn't be consolidating. You don't do that if you're busting at the seams."

However, he believes the new manufacturing plan is a good business decision: "It shows, without a doubt, that Schlumberger is in it for the long run. If they were going to sell [the ATE operations], there's no way they would spend that kind of money," he reasons.

The new structure is currently being put into place on both sides of the Atlantic and across the Pacific. In Europe, where the semiconductor slump has bitten less painfully than in the United States and Japan, Schlumberger's ATE operations may fare better. Explains Prime Data researcher Neff: "In 1986, Europe was strong relative to the U.S. ATE buying held up, and Schlumberger participated in that strength. But every ATE company was helped out by European buying." However, Neff adds that the company did no better overseas than its U.S. competitors.

Schlumberger has hardly had the Midas touch with ATE



Source: Prime Data Inc.

> Britain alone accounts for half of Factron's sales in Europe

Gouilloud claims that Schlumberger is better placed than its competitors in ATE because its presence is more widely spread around the globe. He says: "We have the world's best territorial coverage. It's not only because we have plants, engineering and research groups in the U.S., Europe and Japan. Equally significant is Schlumberger's long tradition as a multinational company."

In Europe, Factron designs and produces board testers at a plant in Ferndown, England, while Sentry's components testers are produced in Saint Etienne, France. "Both plants are closely linked, not only with the history of Schlumberger, but with that of European ATE," says Gouilloud.

Factron's British operation is the successor to Membrain, a British company specializing in functional ATE, which Schlumberger acquired in 1970. Its name was changed to Factron in 1984 in order to identify it more closely with Schlumberger's U.S. products. "The idea was to convey the philosophy of the company more effectively," says Jeff Pitman, vice president and general manager of Factron, Europe. However, the Membrain name is still used on some of Factron's British equipment.

Military traditions

The Membrain tradition also explains why Britain alone accounts for half of Factron's sales in Europe. Pitman says: "We are particularly strong in Britain because we are the No. 1 supplier of ATE equipment to the British military market."

In Saint Etienne, the present site of the Sentry plant was occupied by an instruments test equipment factory when Schlumberger took over Fairchild's assets in 1979. Jean-Pierre Longere, vice president and general manager of Sentry, Europe, says: "Fairchild already had people working on ATE at this French facility. Schlumberger decided to turn the plant into a full-scale chip test manufacturing center in order to be close

to Europe's semiconductor manufacturers."

Longère explains: "That is why Sentry's S15 20-megahertz tester was originally designed and marketed in Europe, although it is now also being manufactured in the U.S. and, later, will be made in Japan. We believe we have an edge on our competitors because our customers are close to our plants."

The growth of the European workforce at Sentry and Factron contrasts with the reduction of personnel in the United States. In 1980, 300 people were employed at the European plants. Today they number 680. In the United States the workforce at Schlumberger Technologies is now 4,000 fewer than a year ago.

Europe's total available market for chip testers was estimated at $43 million last year by industry analysts. "We have captured half of that market," claims Sentry's Longère. He adds: "We have the advantage of being the only major production center in Europe for very large scale integrated circuit [VLSI] testers."

Stressing the importance of industrial and marketing presence in Europe, Robert J. Valentine, vice president and manager of Schlumberger's Factron division, says: "Schlumberger is committed to being a success not just in technology but also in its local environment. That's why our visibility in Europe is so important. It also means that we have to answer the specific needs of our European customers just as we respond to those in the U.S. and Japan by developing software and engineering know-how to meet their requirements."

> "The wave of mergers between European semiconductor companies confronts us with a challenge"
>
> Jeff Pitman of Factron, Europe

Valentine adds: "More and more customers want to take Sentry-Factron solutions together as a package. As Europe's semiconductor firms consolidate, they are likely to be conservative in investing in new test equipment until they put into operation their long-term plans."

After shrinking by almost 20% over the past three years, Europe's board level ATE business is now on the upturn. Pitman comments: "It won't grow as fast as in the boom years, although chip manufacturers are reporting a recovery. The wave of mergers between European semiconductor companies confronts us with a challenge. We have to be particularly sensitive to the demands of the new groups created by the alliances between ITT Corp. and France's Compagnie Générale d'Electricité; Thomson Semiconducteurs with Italy's SGS Microelettronica; and also between Britain's General Electric Co. and Plessey Co. Plc in developing the System X central office switch. Factron has long counted L.M. Ericsson, France's Matra and Compagnie Générale de Constructions Téléphoniques among our customers. Now we hope to be able to supply CGCT under its new Ericsson-Matra management."

Revolution or tea party?

Pitman believes that the advent of computer-integrated manufacturing will "make Europe's earlier Industrial Revolution look like a tea party." He adds: "That's why organizations like Schlumberger Technologies have to provide new resources and intellectual information to help our customers through. ATE suppliers have to be increasingly able to adapt to a more and more competitive marketplace."

Looking at the global picture, Gouilloud says: "Schlumberger's ATE customers have three major matters of concern. These are the emergence of the Japanese semiconductor industry, their own excess plant capacity and also quality. In fact, customers' concern about quality is the result of the convergence between the Japanese challenge and the incredible complexity of modern VLSI chips."

Gouilloud adds: "VLSI sets a mammoth problem for ATE manufacturers in design and testing because of the huge number of transistors now sitting on a chip. The technology leap between the ATE systems of 10 years ago and those of today is bigger than that between designing a Beechcraft [light airplane] and a Boeing 747."

However, he says he is convinced that Schlumberger can meet chip manufacturers' demands because it can draw on vast software expertise in its own ranks to solve the new design and test problems. But he admits: "The sale of Fairchild will deprive us of our immediate access to semiconductor knowledge inside our own company. In the future, we shall depend more on information from other chip manufacturing firms. However, even if our relationship with Fairchild is not as comfortable under its new owners, I hope Fairchild will stay close to us."

> "The sale of Fairchild will deprive us of our immediate access to semiconductor knowledge in our own company"
>
> Gouilloud of Schlumberger Technologies

Gouilloud also stresses the need for Schlumberger to develop links with Japanese semiconductor firms as close as those with its ATE customers in the United States and Europe. He says: "A large share of the chip testing market is in Japan. That is why Sentry operates a plant there in Fuchinobe. We are working closely with Nippon Telephone & Telegraph Co. on software development and have sold them one of our electron-beam test machines. NTT is particularly important to us because of its size and its influence on Japanese industry with special emphasis on telecommunications. Our work in Japan enables us to help our customers elsewhere to achieve quality and cycle times that rival those of the Japanese chip makers."

The Schlumberger Technologies chief says that many of these customers are building their printed-circuit boards more efficiently than in the past. "But some have rejection rates of between 20% and 30% for their boards," he points out. "They would like to have only 5% — and the Japanese are showing them that it can be done."

Gouilloud has no illusions about the future. "Semiconductors are a difficult business to be in," he says. "But, at Schlumberger Technologies, we consider it is an exciting and worthwhile business. ATE equipment will be continuously upgraded as chip designers create denser circuits with faster clock rates. As a supplier, our task is to reduce the cost of our products so that chip makers can restore their profit margins." □

KEYBOARDS

Optimistic input: The good word on the keyboard comeback

Helped by a weaker dollar, U.S. keyboard makers are enjoying some of the best growth and profits they've seen in years

By Bruce C.P. Rayner

Coming off a three-year shakeout, most top keyboard makers are starting to see the signs of a renaissance. Led by a revival in the personal computer market, growth in the $1 billion keyboard market is expected to be between 10% and 15% for 1988.

But for those merchant keyboard makers that have survived the industry restructuring and are reporting profits again, attempts to build market share will be met by cutthroat competition — from both on and offshore and in both the custom and standard markets. Still, most players are optimistic about the future.

"The market is very bullish," insists Dan Mertens, corporate marketing manager of Key Tronic Corp., one of the industry's leaders. The Spokane, Washington-based company reported fiscal 1987 sales of just over $107 million, down from a high of $122.7 million in fiscal 1985. The signs of the uptick materialized earlier in the year, says Mertens, as Key Tronic's 1987 fourth quarter, ended June 30, was the most profitable in the last three years. Sales for 1988 are expected to be up by around 15%, he adds.

Similarly, John Overby, president and chief executive of Advanced Input Devices Inc. (AID), a $40 million keyboard maker in Coeur d'Alene, Idaho, expects sales growth of 40% in 1988 as orders from original equipment manufacturers, including AT&T and IBM, enter the production pipeline. The recovery materialized in 1987, Overby claims, pointing to 70% sales growth for the year to date. In the last 12 months, AID has added 500 additional employees and an additional 15,000 square feet of factory space. Another 25,000 to 50,0000 square feet will be added in 1988, says Overby.

HONEYWELL's TIDDENS: "We see the market for keyboards growing, not dramatically, but at a reasonable growth rate of around 10% to 15%"

Others are more conservative. "We see the market for keyboards growing, not dramatically, but at a reasonable growth rate of around 10% to 15%," says Mark Tiddens, director of marketing at Honeywell Keyboards, a division of Honeywell Inc., based in El Paso, Texas.

Tiddens says there was a resurgence in business in late 1986 as personal computer companies started to ramp up production. But by mid-1987, he adds, many of those same companies were beginning to "re-evaluate" their inventory levels with the result that there has been some "flattening" out of sales now.

Stories to tell

All of the keyboard makers that survived the market upheaval have stories to tell of the lean years of 1985 and 1986: many were victims of downsizing; some have moved offshore and some have been targets for takeovers. The industry that exists today bears little resemblance to that of 1985.

Cost cutting has been at the top of everyone's list. Simply to stay competitive with foreign suppliers, many domestic keyboard makers have adopted automation as a way to cut the high-priced domestic labor bill and, at the same time, to improve quality. Also, technologies such as membrane and conductive rubber, which supersede the older contact-switch type, are becoming more mainstream. Keyboards using these technologies have fewer moving parts and are of a simpler design which lends itself to lower cost of production. The advent of membrane technology is largely because IBM and Digital Equipment Corp. adopted it in their keyboards.

Although the worst of the market downturn is behind them now, many keyboard makers still believe that more restructuring has to take place. "Selling prices have declined by 20% for the last two years," says Syed Hasan, director of marketing with Maxi Switch, a division of EECO Inc. He claims that as long as prices continue to erode, the shakeout will continue.

In the maturing "full-travel" keyboard market — the typewriter-style keyboard used in most personal computer and terminal applications — at least five major players have disappeared in the last three years, leaving a field of about 20 companies with sales of over $8 million each: those to exit include Stackpole Corp. and General Instrument Corp. Others have benefited from this: Cortron, an Elmhurst, Ill., keyboard maker, acquired Stackpole's mechanical-contact technology and much of the company's equipment, says Kenneth

Bucheit, Cortron's sales and marketing manager.

Some diversified companies that had keyboard operations have since abandoned them. AMP Keyboard Technologies Inc., a subsidiary of AMP Inc., left the full-travel keyboard business in 1985 and is focusing instead on the flat-panel keyboard market. Flat-panel boards are used in a myriad of applications, from microwave ovens to cash registers. They also are used in personal computer touch pad applications. The prices of full-travel keyboards offered by Taiwanese and Japanese competitors drove AMP away, says Hugh Aiken, general manager of AMP's keyboard business. But Aiken is not complaining about the decision to get out of the full-travel sector. "We have done very well" in the flat-panel business, he says. Aiken puts the growth rate for flat panels at between 10% and 20% in 1987.

Takeover targets

If a company managed to survive the downturn intact, it often became a target for a takeover bid. That is how Honeywell Keyboards came into existence in January of this year. Formerly called Micro Switch, the manufacturer of both full-travel and flat-panel keyboards is now one of the top three domestic keyboard makers, says Honeywell's Tiddens. The division's engineering, marketing and administration is maintained in El Paso, but production and assembly facilities have been set up in Freeport, Ill., and Juarez, Mexico.

Even though flat panel accounts for only 10% of Honeywell's business, the market is growing at about 35% a year, claims marketing director Tiddens. Although Tiddens agrees with Aiken that the flat-panel business is a high-growth market, he complains it is very fragmented.

While Micro Switch was acquired by a U.S. company, some takeovers have come from foreign companies, resulting in radical internal restructuring. Four years ago Minebea Ltd., also known as NMB, a Japanese ball-bearing manufacturer, took over Hi-Tek, a 20-year-old Garden Grove, California-based keyboard maker. Subsequently, the Garden Grove facility was shut down and all production was moved to Thailand. Like Honeywell, NMB Hi-Tek has kept its administration, engineering and marketing in the United States to stay closer to its customers.

Similarly, two years ago, Alps Electric (USA) Inc. — a wholly owned subsidiary of Alps Electric Company Ltd. of Japan — bought out the Apple Computer Inc. keyboard facility, also in Garden Grove. Alps is still Apple's primary keyboard supplier as well as a supplier to Texas Instruments Inc., independent industry sources say.

Alps has a global strategy when it comes to the keyboard market. The main facility is in Onahama, Japan, but Alps has established plants in Britain, Korea and Taiwan. The company specializes in high-volume contract manufacturing for "the major" computer companies, says Scott Petermann, director of marketing for the OEM operations of the U.S. subsidiary.

> Although the worst of the downturn is over, many keyboard makers still believe more industry restructuring has to take place

Possibly less dramatic than closeouts and buyouts, but equally significant, is the move offshore by domestic companies. Many U.S. keyboard makers have set up assembly plants offshore, either in the Far East or Mexico. For example, Maxi Switch moved its operations from Minnesota to Phoenix in February, 1986 and has set up four assembly facilities in Nogales, Mexico. Similarly, The Cherry Corp. is phasing out its keyboard operation in Waukegan, Ill., and will target both the U.S. and European markets from its West German facility.

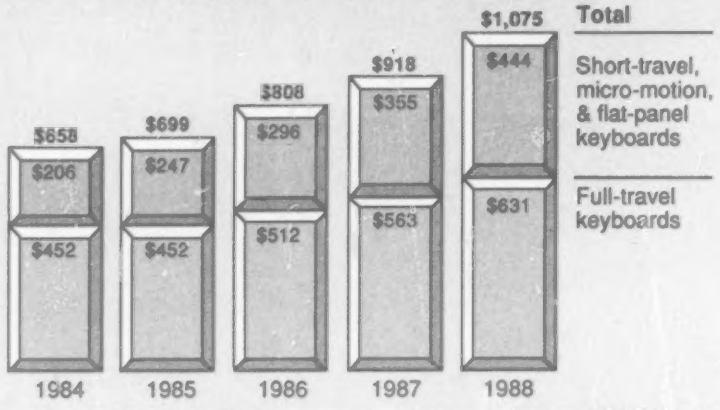
On or offshore?

While the advantages of cheap foreign labor, either in the Pacific Rim or in Mexico, appear obvious, hidden costs of maintaining these distant operations do exist: inventory is often tied up in shipping; design changes are difficult to make; and quality of assembly can be low. These issues are particularly troublesome in the custom market where customer service, both pre- and post-sale, are crucial. While the standardized market for the 101-key and 84-key IBM-compatible keyboards is growing — it is valued at around $30 million — the custom market still accounts for over 90% of all OEM business, Honeywell's Tiddens estimates.

Now that the Pacific Rim currencies are beginning to move up in relation to the U.S. dollar, the cost advantages of moving assembly offshore appear to be lessening. Low-cost producers in Hong Kong, Singapore and Taiwan that have targeted the high-volume standard keyboard market are becoming less price-competitive as their currencies begin to rise against the dollar. Mexico, however, remains an attractive alternative because of its proximity to the

U.S. keyboard makers are seeing a return to healthy business

Total U.S. merchant keyboard market from both domestic and foreign sources ($ millions)



Sources: Venture Development Corp. and ELECTRONIC BUSINESS

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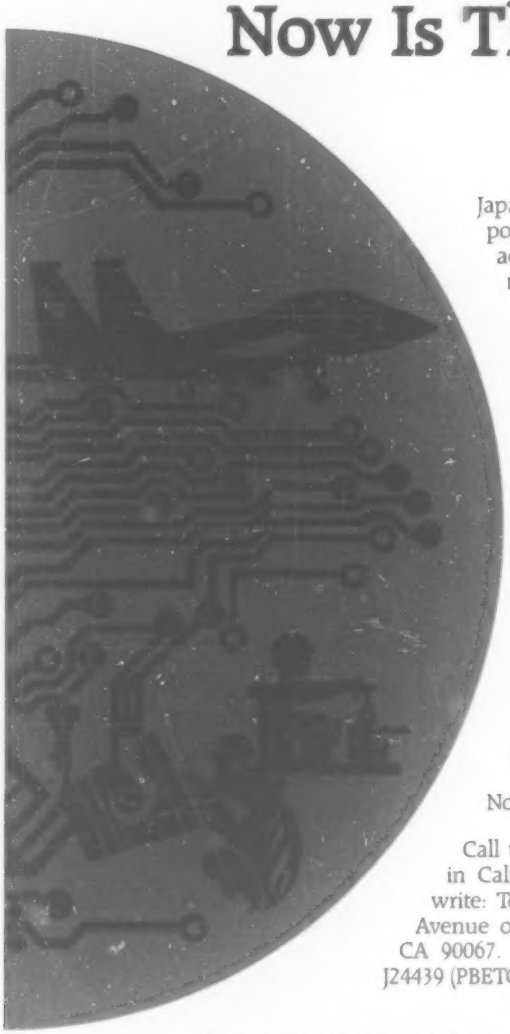

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The Trading Company

U.S. market and the close control that a domestic manufacturer can exert. Also, many keyboard makers insist that the quality of product made south of the border is comparable to that obtained with domestic manufacturing.

While current OEM contracts with offshore vendors that are in the production phase will probably not be affected by the dollar's fall, there is expected to be some impact on new OEM business in 1988. Cortron's Bucheit says he is already seeing some OEMs that were purchasing from Taiwanese suppliers returning to domestic sources. This trend is most noticeable in the high-end product price range, he says.

As U.S. producers look to the continuation of a weak dollar for some reprieve, the trend toward a standardized market intensifies. Many U.S. manufacturers are keen to exploit its potential, claiming that they have the upper hand in customer service and proximity to the market. Key Tronic's Mertens insists that his company is "very aggressive in moving into the standard market." With facilities in Ireland and Taiwan, and headquarters in Spokane, Washington, Mertens claims Key Tronic can service the standard market better than most by offering competitively priced units with the added advantage of being an "onshore" producer.

As the keyboard becomes more of a standard "peripheral" component for the personal computer, new ways are being developed to get the plug-compatible product to market. While OEM sales still account for the lion's share of business, sales-to value-added resellers, systems integrators and distributors are starting to catch on. Both Key Tronic and Maxi Switch and are actively exploring these avenues. Key Tronic sells to regional retail distributors, VARs and systems integrators and is looking to grow in these markets, says Mertens.

Hasan at Maxi Switch admits that Japanese standard keyboard producers, like Fujitsu Ltd., are very aggressive, but he also believes that the exchange rate is really beginning to hurt them. Furthermore, they are disadvantaged by distance, he says. "We offer what no other Far East supplier can: service and point of sale in the U.S." Hasan claims Maxi Switch was the first to come out with a cloned IBM 101-key keyboard. The company sells to OEM clone makers and into the VAR market, which is still growing, he says. □

DATABASE

Recovery pause

New orders for computers and office machinery took a bit of a tumble in August. After rising a revised 12.1% on a seasonally adjusted basis from June to July, new orders dropped 6.7% in August to stand at $4.8 billion. This is the first monthly decline since the 21% drop in January. The computer market was not alone as most major industries experienced decreases in new orders. On a year-to-date basis, new orders for computers and office equipment were up 4.5% from the same eight-month period last year. Backlogs also had a mild setback in August after rising steadily since February. However, at $19.2 billion, they are at their second-highest level since the end of 1985.

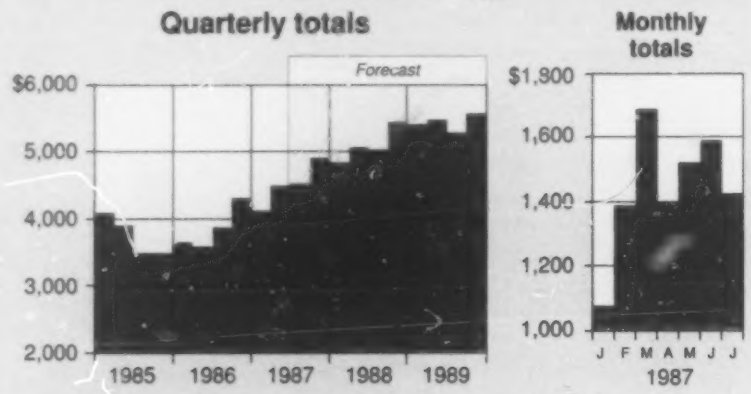
On the positive side, shipments were up just over a tenth of a percent in August, and that was on top of a 5.9% rise in July. Imports outpaced exports for the third time since the start of the year. Exports of $1.4 billion represented a drop of 10.4% from June, while imports increased 1.7% to $1.6 billion. Prices of foreign goods are generally more expensive because of the dollar's depreciation, so a rise in imports on a dollar basis was not unusual. The strong U.S. economy is keeping demand for foreign goods high. On a cumulative basis through July, this industry had a trade surplus of just $49 million.

Edited by LINDA STALLMANN

More information can be obtained from Madeline Franchi, senior economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158. Phone: (617) 964-3030.

Computer exports

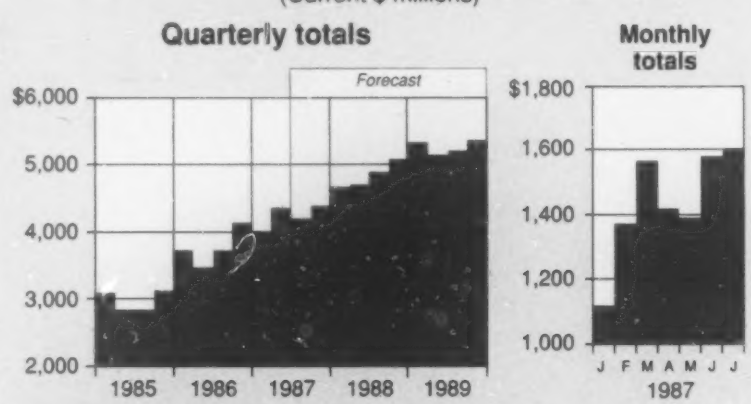
(Current $ millions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer imports

(Current $ millions)



Source: U.S. Department of Commerce; Forecast: Cahners Economics

Computer market database

	Latest month	Previous month	Change	Year ago	Change	Next year	Change
Industrial production (SA, 1977=100, July)	270.4	275.2	-1.7%	257.4	+5.1%	318.7	+17.9%
Shipments (SA, $ millions, August)	$4,899	$4,892	+0.1%	$4,737	+3.4%	$5,884	+20.1%
New orders (SA, $ millions, August)	$4,837	$5,183	-6.7%	$5,173	-6.5%	$5,506	+13.8%
Unfilled orders (SA, $ millions, August)	$19,214	$19,276	-0.3%	$18,631	+3.1%	$21,505	+11.9%
Inventory-to-shipment ratio (SA, August)	1.97	1.96	—	2.23	—	2.01	—
All employees (thousands, August)	456.6	456.6	+0.0%	475.3	+4.1%	495.53	+8.5%
Production workers (thousands, August)	150.8	148.8	-1.3%	161.8	-7.3%	164.29	+8.9%
Exports ($ millions, July)	$1,422	$1,587	-10.4%	$1,231	+15.5%	$1,683	+18.4%
Imports ($ millions, July)	$1,600	$1,574	+1.7%	$1,400	+14.3%	$1,645	+2.8%

SA = seasonally adjusted, all other data is not seasonally adjusted

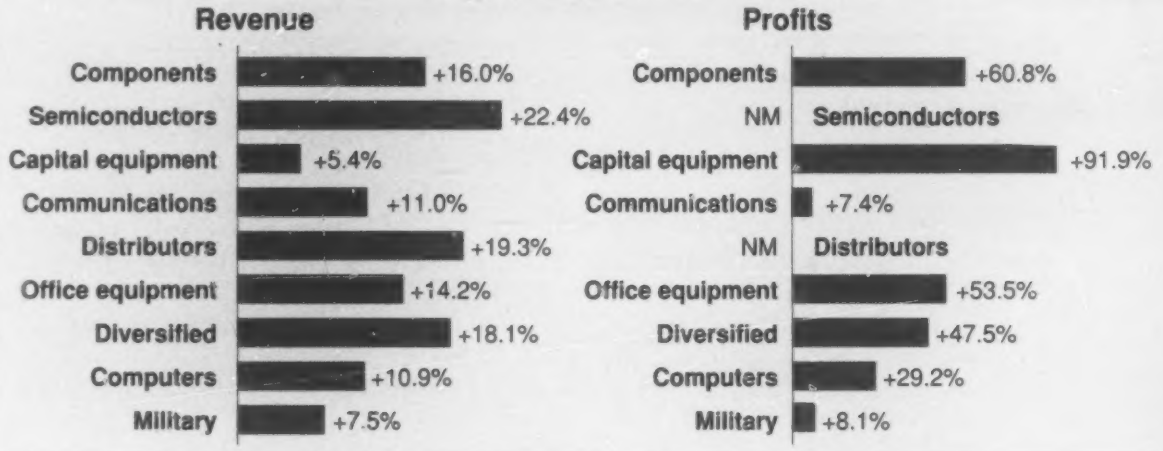
Data sources: Federal Reserve Board, U.S. Bureau of the Census and U.S. Bureau of Labor Statistics
All data for SIC 357, except industrial production, SIC 357-9. Forecasts: Cahners Economics

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 3rd quarter of 1986 to 3rd quarter of 1987



	3rd quarter figures				Year-to-date figures				
Components (other than semiconductors)	Revenue 3rd quarter 1987 ($ millions)	Change from 1986	Profits 3rd quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
AMP	$572.7	19.0%	$62.8	49.1%	$1,684.5	18.1%	$179.4	52.0%	Sept. 30
AVX	70.4	49.0%	3.9	802.1%	192.1	32.6%	11.2	NM	Sept. 30
Augat	78.8	18.5%	1.8	-25.5%	232.3	18.6%	8.2	16.7%	Sept. 27
BRIntec	79.7	0.5%	1.9	-26.7%	246.6	3.5%	5.6	-48.5%	Sept. 30
CTS	62.8	1.2%	3.5	770.8%	190.3	5.7%	7.1	NM	Sept. 27
Kollmorgen	70.6	-3.5%	1.3	NM	217.0	-12.6%	-1.1	NM	Sept. 30
Molex	112.2	20.7%	12.8	18.5%	314.2	21.9%	35.9	22.3%	Sept. 30
Segment composite	**$1,047.1**	**16.0%**	**$86.0**	**60.8%**	**$3,076.9**	**14.3%**	**$246.5**	**58.8%**	
Semiconductors									
Advanced Micro Devices [1]	$260.9	13.9%	-$53.8	NM	$734.5	16.4%	-$45.4	NM	Sept. 27
Intel	501.1	54.6%	80.5	NM	1,334.6	46.8%	152.5	NM	Sept. 27
International Rectifier	37.8	-0.3%	-2.9	NM	113.1	0.0%	-3.4	NM	Sept. 30
LSI Logic	68.9	48.0%	3.2	NM	183.9	31.5%	5.6	159.7%	Sept. 30
Texas Instruments	1,416.3	13.4%	69.1	393.6%	4,059.8	11.6%	214.8	1,515.0%	Sept. 30
Western Digital	140.1	48.0%	12.0	60.9%	402.4	55.3%	36.2	65.6%	Sept. 26
Segment composite	**$2,425.1**	**22.4%**	**$108.2**	**NM**	**$6,828.4**	**20.0%**	**$360.2**	**NM**	
Capital equipment									
Computervision	$132.3	5.1%	$1.5	29.4%	$408.7	14.1%	$11.4	NM	Sept. 30
Tektronix	299.5	-1.8%	1.8	-88.0%	1,070.3	3.7%	20.9	-44.7%	Aug. 22
Teradyne	83.1	0.1%	-0.2	NM	241.2	3.7%	-7.0	NM	Sept. 30
Varian	276.0	16.8%	5.3	NM	768.0	13.2%	13.5	NM	Oct. 2
Segment composite	**$790.9**	**5.4%**	**$8.3**	**91.9%**	**$2,488.1**	**8.1%**	**$38.8**	**225.7%**	
Communications									
Avantek	$45.6	1.8%	$1.6	-43.2%	$148.7	8.2%	$9.9	1.5%	Sept. 12
Aydin	37.1	16.1%	1.9	13.2%	107.8	5.3%	6.2	15.1%	Sept. 30
DSC Communications	78.8	11.3%	4.2	41.8%	232.8	1.4%	9.5	9.3%	Sept. 30
Dynatech	88.1	14.4%	5.7	-10.9%	252.4	16.4%	15.0	-17.1%	Sept. 30
General DataComm	45.6	-1.5%	-3.1	NM	148.3	8.3%	-0.6	NM	Sept. 30
Northern Telecom	1,158.1	12.2%	69.5	5.3%	3,554.4	15.8%	207.2	14.5%	Sept. 30
TIE/communications	67.8	0.8%	-0.7	NM	191.1	-18.4%	-4.8	NM	Sept. 30
Segment composite	**$1,521.2**	**11.0%**	**$79.0**	**7.4%**	**$4,635.5**	**12.3%**	**$242.3**	**14.3%**	

[1] Includes Monolithic Memories Inc. since August 13, 1987 acquisition

NM = Not meaningful; company had a loss in the base year

(Continued)

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

	3rd quarter figures				Year-to-date figures				
Distributors	Revenue 3rd quarter 1987 ($ millions)	Change from 1986	Profits 3rd quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
Anthem Electronics	$48.7	36.0%	$1.3	74.6%	$140.0	52.2%	$3.1	30.1%	Sept. 30
Arrow Electronics	156.9	22.9%	3.4	NM	451.6	13.7%	7.4	NM	Sept. 30
Avnet	441.1	21.5%	12.2	103.3%	1,241.4	12.8%	24.4	67.1%	Oct. 2
Ducommun	115.7	4.1%	-2.5	NM	339.4	-2.4%	4.7	NM	Sept. 30
Pioneer-Standard	60.5	15.8%	1.3	314.4%	175.5	14.0%	3.1	503.7%	Sept. 30
Segment composite	**$822.8**	**19.3%**	**$15.6**	**NM**	**$2,347.9**	**12.3%**	**$42.6**	**NM**	
Office equipment									
Diebold	$109.3	8.9%	$9.2	26.8%	$319.5	5.2%	$23.8	-4.4%	Sept. 30
NCR	1,339.5	13.8%	97.8	33.3%	3,820.6	15.5%	257.9	27.4%	Sept. 30
Pitney Bowes	550.5	11.1%	46.0	18.2%	1,607.1	12.9%	131.5	17.3%	Sept. 30
Savin	88.8	-1.6%	-3.0	NM	265.0	-5.4%	-1.0	NM	Sept. 30
Wang	693.0	15.9%	22.5	NM	2,262.9	13.1%	60.4	NM	Sept. 30
Xerox	3,800.0	15.2%	134.0	19.6%	10,700.0	16.3%	423.0	12.2%	Sept. 30
Segment composite	**$6,581.1**	**14.2%**	**$306.5**	**53.5%**	**$18,975.2**	**14.9%**	**$895.8**	**28.2%**	
Diversified									
General Instrument	$284.9	71.3%	$15.0	361.5%	$805.9	67.3%	$33.8	187.6%	Aug. 30
Gould	230.4	1.3%	4.8	11.6%	690.5	1.3%	16.3	-44.0%	Sept. 30
Harris	506.6	7.9%	19.9	22.5%	1,721.9	10.1%	68.0	40.4%	Oct. 2
Honeywell	1,636.7	27.5%	69.6	130.5%	4,694.2	24.8%	167.6	51.8%	Sept. 27
Motorola	1,672.0	16.8%	70.0	125.8%	4,857.0	13.8%	206.0	57.3%	Sept. 30
N.A. Philips	1,226.9	13.2%	2.8	-83.9%	3,398.5	7.0%	22.4	7.2%	Sept. 27
Tandy	838.2	12.9%	64.3	47.0%	2,351.8	10.6%	159.0	41.2%	Sept. 30
Zenith	591.8	15.2%	-25.1	NM	1,677.1	29.5%	-23.8	NM	Sept. 30
Segment composite	**$6,987.6**	**18.1%**	**$221.2**	**47.5%**	**$20,197.0**	**16.4%**	**$649.4**	**43.1%**	
Computers, peripherals and software									
Amdahl	$362.7	64.9%	$36.8	417.3%	$1,022.2	62.4%	$93.0	660.0%	Sept. 25
Apollo	135.0	34.5%	-2.9	NM	390.7	44.3%	11.2	175.6%	Oct. 3
Apple	786.4	54.0%	71.7	117.9%	1,998.8	46.1%	159.0	63.9%	Sept. 25
Control Data	831.4	1.6%	6.7	NM	2,439.0	-0.2%	7.5	NM	Sept. 30
Compaq	313.5	112.9%	36.4	318.6%	791.9	80.7%	87.3	227.3%	Sept. 30
Cray Research	184.6	35.2%	36.1	38.3%	523.7	14.2%	113.0	11.3%	Sept. 30
Data General	332.3	0.7%	3.4	-26.1%	961.1	-1.3%	-86.1	NM	Sept. 26
Digital Equipment	2,529.8	24.1%	269.9	47.8%	7,608.9	23.9%	954.7	61.4%	Sept. 26
Genicom	72.9	85.4%	2.0	-12.6%	214.4	87.5%	7.2	18.5%	Sept. 30
IBM	12,727.0	6.9%	1,208.0	12.2%	36,206.0	5.5%	3,171.0	-6.7%	Sept. 30
Intergraph	157.1	4.1%	18.4	18.6%	445.8	-0.6%	45.1	-11.2%	Sept. 30
Lotus Development	101.2	54.4%	19.1	100.8%	280.0	39.3%	49.1	50.1%	Sept. 30
Mentor Graphics	56.0	24.3%	5.3	82.8%	160.4	29.1%	14.2	100.8%	Sept. 26
Micropolis	75.2	35.7%	7.0	43.0%	207.9	28.9%	20.1	53.0%	Sept. 25
Microsoft	102.6	53.7%	21.3	34.3%	300.8	67.8%	57.6	51.8%	Sept. 30
Miniscribe	103.8	116.7%	8.4	38.5%	246.3	86.6%	22.1	35.1%	Sept. 27
Prime	236.2	6.5%	15.9	31.5%	693.9	10.3%	43.5	32.7%	Sept. 30
Seagate Technology	226.1	19.6%	14.8	-39.5%	743.2	62.4%	92.4	75.4%	Sept. 30
Storage Technology	185.9	4.1%	1.4	-71.8%	541.8	5.9%	8.7	-40.1%	Sept. 30
Stratus Computer	48.8	52.0%	5.3	51.1%	129.0	44.6%	12.9	30.8%	Sept. 27
Sun Microsystems	191.7	108.5%	12.9	93.2%	519.3	129.6%	34.0	118.2%	Sept. 25
Unisys [1]	2,223.2	-8.2%	129.7	145.2%	6,914.0	41.2%	361.1	148.9%	Sept. 30
Segment composite	**$21,983.4**	**10.9%**	**$1,927.8**	**29.2%**	**$63,339.1**	**14.7%**	**$5,278.5**	**14.0%**	
Military									
E-Systems	$302.9	26.8%	$15.8	-3.8%	$911.7	9.3%	$42.7	-8.5%	Sept. 30
GM Hughes	2,517.2	-1.2%	171.2	4.6%	7,824.6	-0.5%	524.4	7.6%	Sept. 30
Logicon	53.1	2.8%	2.5	13.6%	154.8	-0.4%	4.1	-42.6%	Sept. 30
Loral [2]	336.9	113.9%	17.3	34.7%	654.7	111.1%	33.0	25.8%	Sept. 30
Raytheon	1,855.0	8.2%	114.6	12.9%	5,523.0	4.9%	327.2	11.4%	Sept. 27
Singer	467.7	7.9%	18.2	4.6%	1,339.3	8.9%	12.8	-55.1%	Sept. 30
Watkins-Johnson	66.1	4.6%	4.5	3.4%	194.6	2.0%	12.9	-5.4%	Sept. 30
Segment composite	**$5,598.8**	**7.5%**	**$344.1**	**8.1%**	**$16,602.7**	**4.8%**	**$957.1**	**6.0%**	

[1] Last year's results only include Sperry for all of September

[2] 1987 results include Goodyear Aerospace Corp., (acquired on March 13, 1987) now called Loral Systems Group

NM = Not meaningful; company had a loss in the base year